1128

CORRECTED

No. 3081

United States Circuit Court of Appeals

1128

For the Ninth Circuit

MINERALS SEPARATION, LTD., ET AL,

Appellees,

vs.

BUTTE & SUPERIOR MINING COMPANY,

Appellant.

Transcript of Record

Volume 4

(Pages 1321 to 2196, Inclusive)

UPON APPEAL FROM THE UNITED STATES DISTRICT COURT FOR THE DISTRICT OF MONTANA

McKee Ptg. Co., Butte, Mont.

Defendant's Record

United States Circuit Court,

DISTRICT OF MONTANA, NORTHERN DIVISION.

MINERALS SEPARATION, Limited, and MINERALS SEPARATION AMERICAN SYNDICATE, Limited,
Complainants,
vs.
JAMES M. HYDE,
Defendant.

In Equity. No. 1076.

ANSWER.

The answer of James M. Hyde, defendant, to the bill of complaint of the complainant, Minerals Separation, Limited, and Minerals Separation, American Syndicate, Limited.

This defendant, now and at all times saving and reserving unto itself all and all manner of benefit and advantage of exception which can or may be had or taken to the errors, uncertainties or other imperfections contained in the bill of complaint herein, for answer thereto, or so much or such parts thereof as it is advis~~able~~ed it is material to make answer unto, says as follows:

I.

This defendant is not informed, save by the bill of

complaint, that the complainants, or either of them, are corporations organized or existing under or by virtue of the laws of Great Britain, or of any other country, state or nation, or are inhabitants of Great Britain, or any other country, having their principal offices in London, England, or elsewhere, and therefore neither admits or denies the same, but calls foı strict proof thereof.

II.

This defendant admits that he is a resident of Basin, Jefferson County, State of Montana, and an inhabitant of the Northern Division of the District of Montana.

III.

This defendant, upon information and belief, denies that Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard, or John Ballot did invent or were the original, first or joint inventors of any new or useful improvements in Ore Concentration described in the letters patent referred to in said bill of complaint; denies that the alleged inventions set forth in the patent sued upon was not known or used in the United States before the alleged invention thereof by the patentees, said Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot; denies that said alleged invention was not patented or described in any printed publication in any country before their alleged invention or discovery thereof or more than two years prior to their application for letters patent of the United

States therefor; denies that said alleged invention was not in public use or on sale in the United States for more than two years prior to their said application for patent, and had not been patented in any country foreign to the United States on an application filed by them or their legal representatives or assigns more than twelve months prior to the filing of their said application for letters patent of the United States; and deny that said invention had not been abandoned to the public.

IV.

This defendant admits Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard, and John Ballot obtained letters patent of the United States No. 835,-120, dated November 6, 1906, for alleged improvements in ore concentration; but this defendant denies that said patentees were the first or joint inventors or discoverers of said alleged improvements; and denies that the same involved any improvements in ore concentration; and denies that they made due or formal application to the Commissioner of Patents of the United States for letters patent of the United States therefor in accordance with the then existing laws of the United States; and denies that they duly complied in all respects with the conditions and requirements of said laws; and defendant is not informed, and has no knowledge, save by said bill of complaint, as to whether said letters patent No. 835,120 were signed by the Assistant Secretary of the Interior, and countersigned

by the Commissioner of Patents and sealed with the seal of the Patent Office in due form of law, and therefore denies the same; and denies that said letters patent secured to said patentees, their executors, administrators and legal representatives for the term of seventeen years from the 6th day of November, 1906, or any period, the full, exclusive, or any right of making, using and selling the alleged improvements in ore concentration alleged to be shown, described and claimed in said letters patent, throughout the United States and the territories thereof; and this defendant is not informed, and has no knowledge, save by said bill of complaint, that said letters patent are now on record in the United States Patent Office, and calls for strict proof of the same.

V.

This defendant is not informed, and has no knowledge, save by said bill of complaint, that on or about the 7th day of December, 1909, or at any other time, the said Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot, by an instrument in writing, duly, or at all, executed or delivered by them and bearing date of the last-named day, or any date whatsoever, assigned and transferred to the complainant, Minerals Separation, Limited, all, or any, right, title or interest in or to the said letters patent and invention, or that the said instrument in writing was duly, or at all, recorded in the Patent Office of the United States on or about the 28th day of August,

Answer.

1911, or at any other time, and therefore denies the same.

VI.

This defendant is not informed, and has no knowledge, recollection or belief, save by said bill of complaint, that on or about the 10th day of October, 1910

P. 1327, L. 13, insert "or that said Minerals Separation American Syndicate, limited," before "received"

last-named day, or any date whatsoever, granted unto said complainant, Minerals Separations, American Syndicate, Limited, received or accepted the sole, exclusive, or any, right, license, power or authority to apply, use or exercise in the United States of America the alleged invention described in said letters patent No. 835,120, for the term of two years, or any other time, from the said 10th day of October, 1910, or from any other date, together with the option to purchase said letters patent during said term of two years, or any other term, or at all, and therefore denies the same.

VII.

This defendant is not informed, and has no knowledge, recollection or belief, save by said bill of complaint, that the said complainants became or now are the sole owners of all, or any right, title or interest in or to the said letters patent or the said alleged inventions covered thereby, or any or all rights therein

Answer.

by the Commissioner of Patents and sealed with the seal of the Patent Office in due form of law, and therefore denies the same; and denies that said letters patent secured to said patentees, their executors, administrators and legal representatives for the term of seventeen years from the 6th day of November, 1906, or any period, the full, exclusive or any right of

States and the territories thereof; and this defendant is not informed, and has no knowledge, save by said bill of complaint, that said letters patent are now on record in the United States Patent Office, and calls for strict proof of the same.

V.

This defendant is not informed, and has no knowledge, save by said bill of complaint, that on or about the 7th day of December, 1909, or at any other time, the said Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot, by an instrument in writing, duly, or at all, executed or delivered by them and bearing date of the last-named day, or any date whatsoever, assigned and transferred to the complainant, Minerals Separation, Limited, all, or any, right, title or interest in or to the said letters patent and invention, or that the said instrument in writing was duly, or at all, recorded in the Patent Office of the United States on or about the 28th day of August,

Answer.

1911, or at any other time, and therefore denies the same.

VI.

This defendant is not informed, and has no knowledge, recollection or belief, save by said bill of complaint, that on or about the 10th day of October, 1910, or at any other time, said complaint, Minerals Separation, Limited, by an instrument in writing duly, or at all, executed, or delivered, or bearing date of the last-named day, or any date whatsoever, granted unto said complainant, Minerals Separations, American Syndicate, Limited, received or accepted the sole, exclusive, or any, right, license, power or authority to apply, use or exercise in the United States of America the alleged invention described in said letters patent No. 835,120, for the term of two years, or any other time, from the said 10th day of October, 1910, or from any other date, together with the option to purchase said letters patent during said term of two years, or any other term, or at all, and therefore denies the same.

VII.

This defendant is not informed, and has no knowledge, recollection or belief, save by said bill of complaint, that the said complainants became or now are the sole owners of all, or any right, title or interest in or to the said letters patent or the said alleged inventions covered thereby, or any or all rights therein

Answer.

or thereunder within or throughout the United States, and therefore denies the same (and this defendant denies the same); and this defendant denies that the alleged rights or privileges alleged to be secured by the said letters patent have been generally, or at all, acquisced in throughout the United States, or any part thereof, and denies that the said alleged invention described in said letters patent is of great, or any, value, or utility to the complainants herein or to the public generally, or at all, and this defendant denies that the complainants herein have made the said alleged invention profitable to themselves or to the public by careful, elaborate, or any, tests of said invention in its application to a wide, or any, variety of ores, or by extensive, or any, commercial use of the said alleged invention in different, or any, parts of the world, or by numerous, or any, demonstrations of the utility of said invention in the treatment of ores that are mined or treated in the United States, or elsewhere; and denies that the complainants have made, or that they are making, great, or any, efforts toward the introduction of said alleged invention into commercial, or any, use in the United States; and this defendant denies that the complainants have invested large sums of money, or any sums of money, in said alleged invention in the demonstration thereof or the efforts to introduce the same into use in the United States, or in making the same valuable to the public or to themselves; and this defendant denies that complainants will realize or receive large gains and profits, or any gains and profits,

from the said alleged invention if this defendant shall be restrained from practicing said alleged invention.

VIII.

This defendant admits that he was for a period of about one year in the employ of the complainant, Minerals Separation, Limited, such employment having terminated on or about February 1, 1911, but this defendant denies that when thus employed he was instructed by the engineers or experts of the complainant in all or any of the technical details or particulars as to the said letters patent No. 835,120, or the installation or use of the process of ore concentration constituting said alleged invention; and avers that while in the employ of said complainant, Minerals Separation, Limited, as aforesaid, he was instructed in the practice and operation of certain processes which had been invented and discovered long prior to the alleged invention by said patentees of the process set forth in their said patent, and further avers that while he was in the employ of said complainant, Minerals Separation, Limited, he had no knowledge of said United States letters patent No. 835,120, was not instructed regarding the application or use of the process set forth in said patent, never saw said process in operation, and received no information, knowledge, or instruction from said complainant, Minerals Separation, Limited, other than information, knowledge and instruction regarding matters known to the public long prior to the said alleged invention of said Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard, and John

Answer.

Ballot, or their application of letters patent of the United States therefor.

IX.

This defendant denies that well knowing, or knowing at all, the alleged rights secured to said complainants, or contriving to injure said complainants or to deprive them of the benefits or advantages from said alleged invention and letters patent, he did after the issuance of said letters patent, or at any other time, in violation of any of the rights of said complainants or in infringement of said letters patent No. 835,120, or in defiance of any rights of said complainants at the town of Basin, in the County of Jefferson, State of Montana, or elsewhere, install any apparatus for or carry on the use of the process of ore concentration set forth and claimed in the aforesaid letters patent No. 835,120, and denies that he confederated with others, or confederated at all, in such installation or use, or is threatening to further induce others to make such installation or use in infringement of complainants' alleged rights under the said letters patent; and this defendant denies that said complainants have been, or still are, deprived of great gains and profits, or of any gains and profits, that they might or would have otherwise obtained, and further denies that such alleged profits of which complainants have been deprived have been realized or enjoyed by this defendant by or through unlawful acts or doings; and this defendant admits that he has installed an apparatus and operated

a process at the town of Basin, Montana, for the concentration of ores, but avers that said apparatus and process consist in the use of certain principles and machines which were invented and discovered long prior to the said alleged invention of said patentees, and further consists in certain apparatus and operations invented and discovered by this defendant, and further avers that the process practiced by him in the said town of Basin, Montana, does not infringe said letters patent, does not utilize any information conveyed by said letters patent, and consists solely in the application of principles which were either discovered by said defendant or were the property of the public in the United States.

X.

This defendant denies that he has made and received, or is making and receiving, large, or any, profits, or advantages from the infringement of the said letters patent.

XI.

And this defendant denies that he has installed or used the said alleged invention set forth in said letters patent, or that he has committed any other unlawful act in this regard in defiance of the rights of the complainants, and further denies that he has committed any acts whatever which have had the effect of aiding, encouraging or inducing others to infringe said letters patent in disregard of the complainant's rights.

Answer.

XII.

This defendant denies that the complainants have caused any notice to be given to him of the alleged infringement of the alleged rights of complainants in the premises, or that the complainants have requested him to desist or refrain therefrom, and this defendant denies that he has disregarded any such notices, or that

P. 1332, L. 9, insert "of said letters patent or has continued such infringement" before "after"

This defendant further says that said Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard, and John Ballot were not the original first or true inventors of the alleged invention in ore concentration, which said letters patent No. 835,120 purport to embrace, or of any material or substantial part thereof; but that, on the contrary, said alleged invention, and all material and substantial parts had before their alleged invention been fully and clearly described or claimed in the following mentioned letters patent:

Answer.

LETTERS PATENT OF THE UNITED STATES.

348,157	August 24, 1886	C. J. Everson
466,753	January 5, 1892	E. A. Hockley
469,599	February 23, 1892	A. M. Rouse
653,340	July 10, 1900	F. E. Elmore
676,679	June 18, 1901	F. E. Elmore
689,070	December 17, 1901	A. S. Elmore
692,643	February 4, 1902	A. S. Elmore
735,071	August 4, 1903	G. D. Delprat
736,381	August 18, 1903	M. F. R. Glogner
745,960	December 1, 1903	I. F. Good
768,035	August 23, 1904	G. D. Delprat
771,075	September 27, 1904	C. Kendall
776,145	November 29, 1904	C. V. Potter

LETTERS PATENT OF GREAT BRITAIN.

488	February 23, 1860	W. Haynes
12,778	June 5, 1902	Lake (Froment)

Also patented or described and contained in other letters patent, the dates, numbers and grantees of which this defendant is not now able to specify, but prays to be allowed hereafter to add by amendment of this answer or otherwise, if it shall become necessary.

Also illustrated and described in printed publications, the names and dates of which defendant is not able to specify, but prays to be allowed hereafter to add to this answer by amendment or otherwise, if it shall become necessary.

Answer.

XIV.

This defendant avers that for the purpose of deceiving the public the description and specifications filed by the said patentees in the Patent Office were ~~was~~ made to contain more than the whole truth relative to their alleged invention or discovery, and more than is necessary to produce the desired effect.

XV.

This defendant avers that the said patentees were not the original and first inventors or discoverers of any material and substantial part of the thing patented, but that, on the contrary, the process which their said patent purports to embrace was known and used by Edmund B. Kirby, of Rossland, British Columbia, Canada, long prior to the alleged invention and discovery thereof by said patentees, and that said Edmund B. Kirby introduced knowledge of said process into the United States in the month of December, 1903, by filing applications in the United States Patent Office for patents, upon which applications letters patent Nos. 809,959 and 838,626 were granted on January 16, 1906, and December 18, 1906, respectively.

XVI.

This defendant says that the said patentees, Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot have admitted that the alleged invention which said letters patent No. 835,120 purport to

Answer.

embrace, and each and every material and substantial part thereof was old and known to others prior to their alleged invention and discovery thereof, and that said patentees made said admissions in the following described letters patent:

LETTERS PATENT OF THE UNITED STATES.

793,808, Sulman & Kirkpatrick-Picard, application filed October 5, 1903, patented July 4, 1905.

835,479, Sulman, Kirkpatrick-Picard & Ballot, application filed May 29, 1905, patented November 6, 1906.

879,985, Sulman, Kirkpatrick-Picard & Ballot, application filed February 20, 1905, patented February 25, 1908.

LETTERS PATENT OF GREAT BRITAIN.

17,109, August 6, 1903, Cattermole, Sulman & Kirkpatrick-Picard.

20,419, September 22, 1903, Sulman & Kirkpatrick-Picard.

5,260, March 13, 1905, Sulman, Kirkpatrick-Picard & Ballot.

19,709, September 29, 1905, Sulman.

26,712, December 21, 1905, Sulman, Kirkpatrick-Picard & Ballot.

XVII.

Defendant, further answering, says, that the complainants herein are not entitled to the relief prayed for in

their bill of complaint, without this that there is any other matter, cause or thing in the said bill of complaint contained, material or necessary for this defendant to make answer unto, and not hereinbefore sufficiently answered, confessed or avoided, traversed, or denied, is true; all of which this defendant is ready to aver, maintain and prove as this Honorable Court shall direct, and prays to be hence dismissed with his costs in this behalf most wrongfully sustained.

KREMER, SANDERS & KREMER,
Solicitors for Defendant.

SHERIDAN, WILKINSON, SCOTT & RICHMOND,
Of Counsel.

Amendment to Answer.

UNITED STATES DISTRICT COURT, DISTRICT OF MONTANA.

Minerals Separation, Limited, and Minerals Separation American Syndicate, Limited, *Complainants,* *vs.* James M. Hyde, *Defendant.*	In Equity. No. 1076.

Now comes the defendant, James M. Hyde, and amends his answer in the above-entitled suit in the following manner, to-wit:

By canceling that part of his answer following the numeral XIII and extending from and including the twenty-third line of page 9 of said answer through and including the twenty-second line of page 10 [in the printed copy of the testimony the canceled matter extends from the numeral XIII, page —, through and including the lists of patents on page —], and substituting therefor the following:

"This defendant further says that said Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot were not the original first or true inventors of the alleged invention in ore concentration which said letters patent No. 835,120 purport to embrace, or of any material or substantial part thereof, but that, on the contrary, said alleged invention and all material

Amendment to Answer.

and substantial parts thereof had before their alleged invention been fully and clearly described or claimed in the following mentioned letters patent:

LETTERS PATENT OF THE UNITED STATES.

345,951	July 20, 1885	H. Bradford
348,157	August 24, 1886	C. J. Everson
466,753	January 5, 1892	E. A. Hockley
469,599	February 23, 1892	A. M. Rouse
471,174	March 22, 1892	C. B. Hebron and C. J. Everson
653,340	July 10, 1900	F. E. Elmore
676,679	June 18, 1901	F. E. Elmore
6 689,070	~~February~~ December 17, 1901	A. S. Elmore
692,643	February 4, 1902	A. S. Elmore
729,805	June 2, 1903	J. and L. Stoveken
735,071	August 4, 1903	G. D. Delprat
736,381	August 18, 1903	M. F. R. Glogner
745,960	December 1, 1903	I. F. Good
768,035	August 23, 1904	G. D. Delprat
771,075	September 27, 1904	C. Kendall
776,145	November 29, 1904	C. V. Potter
777,273	December 13, 1904	A. E. Cattermole
777,274	December 13, 1904	A. E. Cattermole, H. L. Sulman and H. F. Kirkpatrick-Picard
788,247	April 25, 1905	A. E. Cattermole, H. L. Sulman and H. F. Kirkpatrick-Picard

Amendment to Answer.

793,808	July 4, 1905	Sulman and H. F. Kirkpatrick-Picard
809,959	January 16, 1906	E. B. Kirby

LETTERS PATENT OF GREAT BRITAIN.

488	February 23, 1860	W. Haynes
12,778	June 4, 1902	Lake (Froment)

Also that prior to the supposed invention or discovery of the alleged process patented in said letters patent No. 835,120 by said Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot each and every material and substantial part of said supposed invention or discovery so patented had been invented and used by and was known to the following named persons, and was fully described in applications for letters patent of the United States, deposited and filed by said persons in the United States Patent Office prior to the supposed invention or discovery of said alleged process set forth in said letters patent No. 835,-120 by said Sulman, Kirkpatrick-Picard and Ballot; that said applications were so deposited and filed in the United States Patent Office and that the letters patent of the United States were granted upon said applications as set forth below:

Moritz F. R. Glogner, a resident of Freiburg, in the Kingdom of Prussia, German Empire, on January 27, 1903, deposited and filed in the United States Patent Office his application for letters patent of the United

States, and that letters patent No. 736,381 were granted thereon upon August 18, 1903.

Israel F. Good, a resident of Allentown, Pennsylvania, on October 1, 1902, deposited and filed in the United States Patent Office his application for letters patent of the United States, and that letters patent No. 745,960 were granted thereon upon December 1, 1903.

Guillaume D. Delprat, a resident of Broken Hill, Australia, on January 2, 1903, deposited and filed in the United States Patent Office his application for letters patent of the United States, and that letters patent No. 768,035 were granted thereon upon August 23, 1904.

Cosmo Kendall, a resident of Upper Norwood, Surrey, England, on July 21, 1903, deposited and filed in the United States Patent Office his application for letters patent of the United States, and that letters patent No. 771,075 were granted thereon upon September 27, 1904.

Charles V. Potter, a resident of Balaclava, Victoria, Australia, on January 14, 1902, deposited and filed in the United States Patent Office his application for letters patent of the United States, and that letters patent No. 776,145 were granted thereon upon November 29, 1904.

Arthur E. Cattermole, a resident of Highgate, London, England, on September 28, 1903, deposited and filed in the United States Patent Office his application for letters patent of the United States, and that letters patent No. 777,273 were granted thereon upon December 13, 1904.

Amendment to Answer.

Arthur E. Cattermole, Henry L. Sulman and Hugh F. Kirkpatrick-Picard, all residents of London, England, on March 29, 1904, deposited and filed in the

P. 1341, L. 7, insert after "No", "777,274 were granted thereon upon December 13, 1904. Arthur E. Cattermole, Henry L. Sulman and Hugh F. Kirkpatrick-Picard, all residents of London, England, on March 29, 1904, deposited and filed in the United States Patent Office their application for letters patent of the United States, and that letters patent No."

and that letters patent No. 793,808 were granted thereon upon July 4, 1905.

Alfred Schwarz, a resident of New York City, New York, on April 19, 1905, deposited and filed in the United States Patent Office his application for letters patent of the United States, and that letters patent No. 807,501 were graned thereon upon December 19, 1905.

Alfred Schwarz, a resident of New York City, New York, on May 27, 1904, deposited and filed in the United States Patent Office his application for letters patent of the United States, and that letters patent No. 807,503 were granted thereon upon December 19, 1905.

Edmund B. Kirby, a resident of Rossland, Canada, on December 14, 1903, deposited and filed in the United States Patent Office his application for letters patent of the United States, and that letters patent No. 809,959 were granted thereon upon January 16, 1906.

Edmund B. Kirby, a resident of Rossland, Canada, on December 17, 1903, deposited and filed in the United

Amendment to Answer.

States, and that letters patent No. 736,381 were granted thereon upon August 18, 1903.

the United States Patent O

ters patent of the United States, and that letters patent No. 768,035 were granted thereon upon August 23, 1904.

Cosmo Kendall, a resident of Upper Norwood, Surrey, England, on July 21, 1903, deposited and filed in the United States Patent Office his application for letters patent of the United States, and that letters patent No. 771,075 were granted thereon upon September 27, 1904.

Charles V. Potter, a resident of Balaclava, Victoria, Australia, on January 14, 1902, deposited and filed in the United States Patent Office his application for letters patent of the United States, and that letters patent No. 776,145 were granted thereon upon November 29, 1904.

Arthur E. Cattermole, a resident of Highgate, London, England, on September 28, 1903, deposited and filed in the United States Patent Office his application for letters patent of the United States, and that letters patent No. 777,273 were granted thereon upon December 13, 1904.

Amendment to Answer.

Arthur E. Cattermole, Henry L. Sulman and Hugh F. Kirkpatrick-Picard, all residents of London, England, on March 29, 1904, deposited and filed in the United States Patent Office their application for letters patent of the United States, and that letters patent No. 788,247 were granted thereon upon April 25, 1905.

Henry L. Sulman and Hugh F. Kirkpatrick-Picard, residents of London, England, on October 5, 1903, deposited and filed in the United States Patent Office their application for letters patent of the United States, and that letters patent No. 793,808 were granted thereon upon July 4, 1905.

Alfred Schwarz, a resident of New York City, New York, on April 19, 1905, deposited and filed in the United States Patent Office his application for letters patent of the United States, and that letters patent No. 807,501 were graned thereon upon December 19, 1905.

Alfred Schwarz, a resident of New York City, New York, on May 27, 1904, deposited and filed in the United States Patent Office his application for letters patent of the United States, and that letters patent No. 807,503 were granted thereon upon December 19, 1905.

Edmund B. Kirby, a resident of Rossland, Canada, on December 14, 1903, deposited and filed in the United States Patent Office his application for letters patent of the United States, and that letters patent No. 809,959 were granted thereon upon January 16, 1906.

Edmund B. Kirby, a resident of Rossland, Canada, on December 17, 1903, deposited and filed in the United

States Patent Office his application for letters patent of the United States, and that letters patent No. 838,626 were granted thereon upon December 18, 1906.

By canceling that part of the answer following the numeral XVI and extending from and including the twenty-ninth line of page 11 of said answer through and including the twenty-second line of the twelfth page thereof [in the printed copy of the testimony the canceled matter extends from the numeral XVI, page 11, to the numeral XVII, page 12], and substituting therefor the following:

This defendant says that the said patentees, Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot have admitted that the alleged invention which said letters patent No. 835,120 purport to embrace and each and every material and substantial part thereof was old and known to others prior to their alleged invention and discovery thereof, and have stated that said alleged invention was the invention of others, and that said patentees made said admissions and statements in the following described letters patent, and in the applications therefor and proceedings in the United States Patent Office relating thereto:

LETTERS PATENT OF THE UNITED STATES.

793,808, Sulman & Kirkpatrick-Picard, application filed October 5, 1903, patented July 4, 1905.

835,143, Henry L. Sulman, application filed October 20, 1905, patented November 6, 1906.

835,479, Sulman, Kirkpatrick-Picard & Ballot, application filed May 29, 1905, patented November 6, 1906.

Amendment to Answer.

879,985, Sulman, Kirkpatrick-Picard & Ballot, application filed February 20, 1905, patented February 25, 1908.

LETTERS PATENT OF GREAT BRITAIN.

17,109, August 6, 1903, Cattermole, Sulman & Kirkpatrick-Picard.

20,419, September 22, 1903, Sulman & Kirkpatrick-Picard.

5,260, March 13, 1905, Sulman, Kirkpatrick-Picard & Ballot.

19,709, September 19, 1905, Sulman.

26,712, December 21, 1905, Sulman, Kirkpatrick-Picard & Ballot.

KREMER, SANDERS & KREMER,
Solicitors for Defendant.

It is stipulated that the foregoing amendment to the answer of defendant may be entered, provided, however, that should defendant prevail upon any of the matters set up in said amendment and not set up in his original answer, he may not recover costs for any proceedings prior to the deposition of the witness Eugene A. Byrnes.

MCCONNELL & MCCONNELL,
Solicitors for Complainant.
HENRY D. WILLIAMS,
Of Counsel.
KREMER, SANDERS & KREMER,
Solicitors for Defendant.

Deposition of Jesse C. Gibson.

UNITED STATES DISTRICT COURT, DISTRICT OF MONTANA.

Minerals Separation, Limited, and Minerals Separation American Syndicate, Limited, *Complainants,* vs. James M. Hyde, *Defendant.*	In Equity. No. 1076.

The deposition of Jesse C. Gibson, a witness in behalf of defendant in the above-entitled suit, taken by agreement of counsel before Charles H. Little, a Notary Public in and for the State of Montana, acting by consent of counsel for both parties as Special Examiner under the 67th Rule in Equity as amended, at the office of Kremer, Sanders & Kremer, State Savings Bank Building, Butte, Montana, beginning on Monday, April 1st, 1912, at 10 o'clock in the forenoon.

Appearances: Henry D. Williams, Esq., for complainants; J. Bruce Kremer, Esq., for defendant.

JESSE C. GIBSON, a witness produced in behalf of defendant, having been duly cautioned and sworn, testified as follows:

Direct Examination by Mr. Kremer.

Q. 1. Please state your name, age, residence and occupation.

A. Jesse C. Gibson; 25 years of age; residence,

Deposition of Jesse C. Gibson.

Butte, Montana; occupation, storekeeper for the Butte & Superior Copper Company.

Q. 2. What occupation did you follow immediately previous to your becoming storekeeper at the Butte & Superior?

A. Millman.

Q. 3. Were you employed on a flotation plant operated for the purpose of treating ore at Basin, Montana; if so, in what capacity?

A. I was, as an operator.

Q. 4. What were your duties in that connection?

A. To operate the machine.

Q. 5. By whom were you employed?

A. Butte Superior Copper Company.

Q. 6. Under whose direction were you working?

A. Mr. Hyde, the defendant.

Q. 7. State what was used in connection with the operation of the flotation plant.

A. Oil, acid and heat; that was all.

Q. 8. Did you have charge of the operation of the flotation plant?

A. I did on one shift, of eight hours per day.

Q. 9. How long were you employed as such operator, and between what dates?

A. It was the latter part of July, 1911, up until about February 7th, 1912.

Q. 10. Did you know anything about the so-called flotation process wherein oil and acids are used, before starting to work upon the plant at Basin?

A. I did not.

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Q. 11. What were your instructions as to the regulation of the supply of oils and acids in the process and by whom were they given?

A. I was instructed to use oil and acid to produce the best results. I was instructed by Mr. Hyde.

Q. 12. What were you told was the indication of too much oil and acid?

A. Too much oil was indicated by a flat film on the surface of the water, the mineral forming globules and sinking. Too much acid, the mineral would not float. Too little oil, there was no separation of the minerals and waste. Too little acid, made a lower grade concentrate.

Q. 13. What, if anything, were you told as to the actual quantity of oil and acid you were to use in operating the plant for Mr. Hyde, and by whom were you instructed?

A. The amounts were left entirely to our own judgment, and to use the amount that would produce the best results. That was Mr. Hyde's instructions.

Q. 14. What kind of oil and what kind of acid was used?

A. Oleic oil and sulphuric acid.

Q. 15. In operating the plant, did you weigh or measure the quantity of oil or acid with a view to using any proportion relative to the amount of ore?

A. No.

BY MR. WILLIAMS: The objection is here noted to the testimony as so far developed, that the wit-

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ness is describing the operation of certain physical apparatus which are not produced nor competently proved, and to which the complainants and their representatives have not been granted access for examination. The general objection is therefore made that the testimony is secondary and incompetent, although this objection will be withdrawn if opportunity is given to complainants' counsel and expert to examine the apparatus as to the operation of which the witness is testifying.

Q. 16. When you were operating the flotation plant wherein the flotation process was used, did you have any knowledge of the amount of acid and oil by weight or measure that you were using, or the proportion of same to the amount of ore being treated?

A. I did not.

Q. 17. By what were you guided in the operation of this process?

A. By results obtained.

Q. 18. What would be the course of your procedure in order to obtain the best results?

A. If to my judgment more oil was needed, it was added; if less, I reduced the amount. The same with acid.

Q. 19. How often would you find it necessary to vary the oil and acid supplied in order to obtain the best results that you speak of?

By Mr. Williams: The general objection stated after the answer to Q. 15 is now repeated as to

this question for the obvious reason that no intelligent presentation of the alleged facts as to which the witness has testified can be made, and no intelligent understanding had thereof, in the absence of a complete comprehension of the physical apparatus as to the operation of which the witness is testifying. It is stipulated that this objection may be continued without repetition to all further questions on this line.

By Mr. Kremer: For the purpose of clearness I temporarily withdraw Q. 19.

Q. 20. Describe the flotation plant upon which you operated at Basin, at the time of Mr. Nutter's visit, this being the plant known as the experimental plant.

By Mr. Williams: Objection is made to the description of physical apparatus not produced or submitted to the inspection of opposing parties, as secondary and incompetent.

A. The plant consisted of a series of agitating boxes and spitzkasten. There were six agitating boxes and three spitzkasten on the first machine; my mind is not clear as to the number of boxes on the cleaner machine. The pulp entered the first agitator box; from there flowed to the second; from the second to the third, where it flowed into the first spitzkasten. The tailings from the first spitzkasten went to the first agitator box of the second cell; from there it flowed to the second agitating box; from there to the second spitzkasten. The tailings from the second spitzkasten went

to the third cell, where there was but one agitator box. The tailings from that went to the tailings dump. The concentrates from the three spitzkasten I have just described went to the first agitator box on the cleaner, where they were agitated and flowed into the first spitzkasten on the cleaner. The concentrate made there went to the concentrate bin. The tailings from the first spitzkasten went to the agitator boxes on the second cell of the cleaner, where they agitated and flowed onto the second spitzkasten. The concentrate made on that spitzkasten went to the concentrate bin; the tailings were returned to the second cell of the rougher to be retreated. By the rougher I mean the first three spitzkasten described.

The acid was fed to the pulp in a launder approximately 100 feet from the plant, previous to entering the settling tanks. The oil was added in the first agitator box in the first spitzkasten.

The agitators were a propeller-like blade mounted on vertical shafts, driven by a belt.

Q. 21. What do you mean by the term "cell" that you use in your description?

By Mr. Williams: The same objection.

A. One agitator box and its spitzkasten complete make a cell, or one spitzkasten and its agitator box or boxes make a cell. These are commonly referred to as units.

Q. 22. How often would you find it necessary to vary the oil and acid supplied in operating the process, in order to obtain the best results that you speak of?

A. That was governed by conditions. The change being made as often as needed to produce the best results. It varied greatly, as often as every four or five minutes, and sometimes we wouldn't have to change for half an hour.

Q. 23. Where was the heat, if any, applied in the operation of the plant?

A. In two places, in the oil tank which supplies the oil to the machine, and in the first agitator box of the first unit.

Q. 24. You stated that the oil was added in the first agitator box in the first spitzkasten. Was it added in the agitator box or the spitzkasten?

A. In the agitator box.

Q. 25. What was the condition of the oil that you received for use in the flotation plant; I mean the physical condition?

A. A solid mass.

Q. 26. You refer to heat being used in the plant. What is your judgment as to why this heat was applied?

> By Mr. Williams: Objected to as incompetent, in that it calls for an expression of opinion by a witness who has expressly disclaimed any theoretical knowledge of the subject of which he is testifying.
>
> By Mr. Kremer: Conceding that counsel is correct in that the witness is not testifying as an expert upon the theories of the so-called process, I withdraw the question.

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Q. 27. State what you mean by obtaining the best results in the operation of the so-called flotation process.

A. High grade concentrates and clean tailings.

Q. 28. Do you know Mr. Edward H. Nutter?

A. Not personally acquainted with him; I might know him if I should see him again.

Q. 29. Well, where did you ever see him?

A. In Basin, Montana. On the night of August 10th, 1911, in the experimental plant of the Butte Superior Copper Company.

Q. 30. Detail what occurred between you that evening, and relate the conversation had between you.

A. It was between 11 and 12 o'clock P. M., August 10th, 1911, when Mr. Nutter came into the experimental plant which I was in charge of at that time. My back being turned to the door, he was in the plant before I saw him, and was coming up the steps that led to the platform around the machine. I jumped down from the stand where I was and informed him that we allowed no visitors in the plant and asked him to get out,—told him to get out. He said that that was all right, and wanted to know what I was doing there. I told him that it was none of his business, and again asked him to get out. He then asked me what caused the mineral to float, and also asked me for a sample of the concentrates. I again told him that it was none of his business, whereupon he took a handful of the concentrates and started out of the door. I followed him, stopped him, and asked him what his business was,

and told him that if he had any business around there to go with me and see Mr. Hyde, who lived within a short distance of the plant. He said that he did not care to see Mr. Hyde, but I insisted that he go with me to Mr. Hyde, as I was in charge of the plant, and was instructed to allow no visitors to enter the plant, and might possibly lose my situation for so doing. He told me that I need not worry about losing my situation, that if I would leave my name and address with him he would look out for that. I asked him what kind of a man he thought I was, and that if he was a man he would go with me and see Mr. Hyde. He refused to do so, and went, presumably, to his hotel. I went over to the house, awakened Mr. Hyde and informed him of what had happened.

Q. 31. Was or was not the plant at the time of the visit of Mr. Nutter operating under normal conditions as to the character of feed?

A. It was not.

Q. 32. State why?

A. The mill was down at that time, and we were treating the concentrates made on the vanners, feeding it into the flotation machine by buckets. The vanners were machines in the mill which treated the slimes, the concentrates being wheeled out and piled near the door of the experimental plant.

Q. 33. As I understood you, at the time of Mr. Nutter's visit you were feeding vanner concentrates into the machine directly, instead of the flowing pulp as it ordinarily came from the mill; is that correct?

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A. Yes, sir, that is the idea; that is what we were doing.

Q. 34. As a millman, are you familiar with the general grade of concentrates produced by that machine under ordinary working conditions?

A. Yes.

Q. 35. What would you say as to whether the concentrates procured by Mr. Nutter at the time referred to in your answer to Q. 30 was or was not an average grade of concentrate from that machine?

A. It was not.

Q. Was it a higher or lower grade?

A. Well, I could not say at this time; I don't remember what the concentrate run at that time.

Q. 37. From your experience with this machine, would you say that the sample procured by Mr. Nutter in the manner that it was procured, was a representative sample of the concentrate produced by that machine, even at that time?

A. It was not.

Direct examination closed.

Cross-Examination by Mr. Williams, de bene esse, without waiving the objections heretofore stated to the testimony of this witness, which are here repeated, that descriptions of the construction and operation of a physical apparatus which is not produced and not offered to the inspection of opposing parties, are secondary and incompetent.

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X-Q. 38. You have mentioned an oil tank, and you have said that the oil was fed to the flotation plant. In what manner was the oil conducted from the oil tank to the agitation box at which it entered the pulp?

A. By means of a short pipe and a valve for regulating the supply.

X-Q. 39. Was the oil fed by gravity?

A. Yes.

X-Q. 40. How was the oil warmed in the oil tank?

A. By a steam coil in the oil tank.

X-Q. 41. What was the capacity of the oil tank?

A. I couldn't say as to the actual capacity; I judge about twenty gallons.

X-Q. 42. In how many shifts of attendance was the plant operated each day?

A. Three.

X-Q. 43. And was your shift eight hours?

A. Eight hours.

X-Q. 44. You had to refill the oil tank now and then, did you not?

A. My helper did.

X-Q. 45. About how often did that happen during your shift?

A. It all depended on conditions as to the amount of oil used.

X-Q. 46. Well, as a general average, how often would it have to be refilled during the eight hours when it was in your charge?

A. I couldn't say.

X-Q. 47. Did you ever refill it twice during your shift?

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A. Yes, I have refilled it twice, and more and less.

X-Q. 48. How were the concentrates handled after they came out of the flotation plant?

A. Pumped to the concentrate bins.

X-Q. 49. How many of these concentrate bins were there?

A. I think there were two.

X-Q. 50. On an average, how many times did you fill a concentrate bin during your shift?

A. I don't know.

X-Q. 51. Were the concentrate bins under your charge?

A. No, sir, they were not.

X-Q. 52. Did they overflow one into the other, or did some one have to make some change in the feed when one concentrate bin was full?

A. That was attended to by one of the men in the mill.

X-Q. 53. How were the tailings handled?

A. They were carried away with the mill tailings.

X-Q. 54. What became of them ultimately?

A. They flowed into the settling ponds first, and from there into the Boulder River.

X-Q. 55. Was any of the water used over again?

A. No.

X-Q. 56. You have said that the acid was fed to the pulp approximately 100 feet from the flotation plant, previous to entering the settling tank. Did you have charge of the regulation of the acid supply?

A. I did.

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X-Q. 57. From what was this acid fed into the pulp?

A. From a small iron pot or kettle, through a pipe with a valve.

X-Q. 58. What was the condition of this acid, dilute or concentrated?

A. What you might term crude sulphuric acid.

X-Q. 59. What was the material or metal used in the acid feed pipe and valve?

A. Iron.

X-Q. 60. What was the capacity of the iron pot or kettle from which the sulphuric acid was fed?

A. About three gallons.

X-Q. 61. Was any of the water into which this sulphuric acid was fed wasted or flowed off before the pulp entered the flotation plant?

A. Yes.

X-Q. 62. What you have called a settling tank, into which the acid was fed, is what is commonly known as a dewaterer, isn't it?

A. Yes.

X-Q. 63. Do you know about what proportion of the water was flowed off or separated in the dewaterer?

A. I do not.

X-Q. 64. Do you know what was the proportion of water to ore in the pulp that entered the flotation plant?

A. I do not.

X-Q. 65. Was the dewaterer under your charge?

A. Yes, it was.

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X-Q. 66. Did you have to adjust it at any time?

A. There was a man stationed to do that under my directions.

X-Q. 67. Before the pulp entered the dewaterer, what had been done to the ore and water of which it was composed?

A. The ore had been treated over jigs and tables, where it had been separated, and the slimes sent to the dewaterer and settled.

X-Q. 68. From what part of the dewaterer did the pulp flow to the flotation plant?

A. From the bottom of the dewaterer.

X-Q. 69 Now as to this iron pot or kettle from which the sulphuric acid was fed, on the average, about how often was this refilled during your shift?

A. As often as necessary.

X-Q. 70. And about how often was that, on the average?

A. It varied according to conditions.

X-Q. 71. Did you ever refill it twice during your shift?

A. I refilled it twice, and less and oftener.

X-Q. 72. You have said that when Mr. Edward H. Nutter inspected this flotation plant, you were treating the concentrates made on the vanners. How do these concentrates differ from the ordinary feed of the flotation plant?

A. They were richer.

X-Q. 73. How do you know that?

A. By assay report.

X-Q. 74. About how much richer?

A. Oh, it would vary.

X-Q. 75. From what to what?

A. From 10 to 20 per cent.

X-Q. 76. You have also said that you were feeding this vanner concentrate into the flotation machine by buckets. I suppose the condition of the material in the buckets was about the same as mud, wasn't it?

A. Yes.

X-Q. 77. How did you make a flowing pulp out of it?

A. Had a stream of water running into the agitator box.

X-Q. 78. How long had you been working this way before you saw Mr. Nutter?

A. About three hours.

X-Q. 79. And I take it that you had adjusted matters so as to get the best conditions, had you not?

A. It was impossible to adjust the machine to produce good results under the condition stated.

X-Q. 80. Why was this?

A. The irregularity of feed.

X-Q. 81. But you did the best you could, didn't you?

A. We did what we could under conditions.

X-Q. 82. And you did as well as you could, didn't you?

A. Yes.

X-Q. 83. Had you observed the condition of the flotation froth under these unusual conditions of feed? I

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refer to the period of three hours or so before you saw Mr. Nutter, and about or after that time, while these unusual conditions of feed were maintained?

A. Yes, I had.

X-Q. 84. What did this condition show as to the oil, too much oil or too little oil?

A. It was impossible to tell, as the feed was irregular.

X-Q. 85. It was too much oil part of the time, wasn't it?

A. Too much oil part of the time, and too little at other times.

X-Q. 86. Prior to your employment in charge of one of the shifts at the flotation plant which you have described, what was your occupation?

A. Just prior to my employment as an operator of the flotation plant I was a timekeeper and clerk for the Butte & Superior Copper Company.

X-Q. 87. And prior to that what was your occupation?

A. Millman, jigman.

X-Q. 88. And how long were you employed as a millman or jigman?

A. About two and a half years.

X-Q. 89. When you were started at your work in operating the flotation plant which you have described, was the plant shown to you in operation?

A. No.

X-Q. 90. When you received the instructions that you have described, what was done to show you the

conditions which you were to guard against, as well as the conditions which you were to produce?

A. I was shown the appearance of the machine when too much oil was applied, and when too little oil was applied, and the appearance when the proper amount was applied.

X-Q. 91. And, of course, this was shown to you by the actual operation of the machine?

A. By the actual operation of the machine.

X-Q. 92. And as to the amount of acid used, were you shown the conditions which you have described in the operation of the machine?

A. Yes, sir.

X-Q. 93. Then, just what did you mean in your answer to X-Q. 89, which I now show you?

A. Oh, I want to correct myself there. I understood that you meant previous to that time.

X-Q. 94. You have said that too little acid made a lower grade concentrate. How would you know that the concentrate was of a lower grade?

A. By the appearance of the concentrate and by assays.

X-Q. 95. What was the inside diameter of the oil feed pipe which ran from the oil tank to the agitator box?

A. I do not remember what it was.

X-Q. 96. It was a small pipe, wasn't it?

A. I don't remember whether it was three-eighths or a half an inch.

X-Q. 97. And is that inside or outside diameter?

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A. Inside.

X-Q. 98. And about what was the inside diameter of the sulphuric acid feed pipe which ran from the pot of sulphuric acid to the Dewaterer?

A ~~Q~~. It was either a three-eighths or half an inch.

X-Q. 99. Now as to the oil feed pipe, generally the valve was turned so as not to be wide open; that is true, isn't it?

A. Yes, sir.

X-Q. 100. And this, I suppose, is also true as to the acid feed pipe?

A. It is.

X-Q. 101. In this flotation plant, did the pulp flow directly into a spitzkasten from the agitating box of the same unit?

A. Yes.

X-Q. 102. And where was the opening located through which it flowed?

A. At the bottom of the agitator box.

X-Q. 103. About how wide was the opening?

A. I don't know exactly.

X-Q. 104. About how wide was the spitzkasten, inside dimension?

A. I don't know how wide it was.

X-Q. 105. I hand you a rule and ask you to indicate from memory about what was the width, inside dimension, of a spitzkasten?

A. Oh, 18 or 20 inches.

X-Q. 106. Now also please, from memory, tell me about how wide the opening was from the agitating box to the spitzkasten.

A. About 4 inches.

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X-Q. 107. And there was only one such opening?

Only one

A. ~~It was about 4 inches high, and the same width.~~

X-Q. 108. And about how high was the opening?

A. It was about 4 inches high, and the same width.

X-Q. 109. And was the agitator box the same width as the spitzkasten?

A. It was about the same width; I wouldn't say that it was exactly the same.

X-Q. 110. Was there any inclined deflector in the spitzkasten just over the opening from the agitating box to the spitzkasten?

A. No.

X-Q. 111. Was the wall or partition between the agitator box and the spitzkasten straight up and down and vertical above the opening which you have described?

A. It was.

X-Q. 112. You have said that the tailings from the first spitzkasten went to the first agitator box of the second cell or unit. What conducted it from the spitzkasten to this next agitator box?

A. A centrifugal pump.

X-Q. 113. Where was this centrifugal pump located?

A. At the back of the machine.

X-Q. 114. Was there a separate centrifugal pump for each connection from a spitzkasten to the next agitating box?

A. No.

X-Q. 115. Please now more particularly describe the complete connection for the tailings from one spitzkasten to the next agitator box.

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A. Between which units?

X-Q. 116. First the connection from the first unit of the roughing machine to the agitator box of the second unit.

A. By means of a centrifugal pump.

X-Q. 117. How did the pipe run?

A. From the lower part of the spitzkasten through the centrifugal pump, a pipe leading from the outlet of the centrifugal pump into the first agitating box of the second unit.

X-Q. 118. Where did this pipe enter the agitating box of the second unit?

A. At the top.

X-Q. 119. Now please describe the connection for the tailings from the spitzkasten of the second unit to the agitator box of the third unit.

A. By gravity and a hydraulic lift.

X-Q. 120. How was this hydraulic lift imparted?

A. A small pipe led into a tee and carried water under pressure. That water would force the pulp into the next agitating box.

X-Q. 121. And where did the pulp enter this last agitating box, top or bottom?

A. Bottom.

X-Q. 122. At the center or at the side?

A. About the center.

X-Q. 123. Now how about the levels of the three spitzkasten of the roughing machine?

A. The first two were on a level; the third being lower than the other two.

X-Q. 124. As I understand it, the froth flowed from these three spitzkasten into the same launder?

A. Yes, sir.

X-Q. 125. Now, as I understand you, in this roughing machine there were three agitator boxes in the first unit; is that right?

A. Yes, sir.

X-Q. 126. And how many agitator boxes were in the second unit?

A. Two.

A. One

X-Q. 127. And, of course, in the third unit there was one?

X-Q. 128. Now please, if you can remember, tell me how many spitzkasten there were in the cleaner machine.

A. Two.

X-Q. 129. And how many agitator boxes in the first unit in this machine?

A. I am not positive, but I think there were three.

X-Q. 130. And how many agitator boxes in the second unit in this cleaner machine?

A. One.

X-Q. 131. Now how were the tailings conducted from the first spitzkasten of the cleaner machine to the agitator box of the second unit of this machine?

A. By gravity and by a similar hydraulic lift to the one I have already described.

X-Q. 132. Did the water under pressure for this hydraulic lift flow from the same source as for the other hydraulic lift which you first described?

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A. Yes, they were both connected to the same supply pipe.

X-Q. 133. And how was the pressure generated for this feed?

A. It was a gravity feed.

X-Q. 134. Now how were the tailings conducted from the second spitzkasten of the cleaner machine to the second cell or unit of the rougher, to be retreated?

A. Through a pipe to the centrifugal pump, which took the tailings from the first unit to the second unit.

X-Q. 135. And how was this centrifugal pump driven?

A. By a belt.

X-Q. 136. You have said that the condition of the oil when you received it for use in the flotation plant was that of a solid mass. Was it always in this condition?

A. Yes, sir.

X-Q. 137. Then did you have to put it into the oil box in chunks?

A. Yes.

X-Q. 138. And in what sort of a receptacle was this oil delivered to you for use?

A. In wooden barrels and iron drums.

X-Q. 139. Was this flotation plant operated continuously by three shifts of men?

A. It was, except when it was down for repairs or when the mill was down.

X-Q. 140. Who were the two other shift foremen or operators?

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A. T. C. Wilson and Thomas Byrnes.

X-Q. 141. Have you any idea of the capacity of that flotation plant, working twenty-four hours a day?

A. I have not.

X-Q. 142. Was any complaint ever made to you of not having operated the plant to full capacity at any time while it was in your charge?

By Mr. Kremer: Objected to for the reason that it is incompetent, irrelevant and immaterial, improper cross-examination, and if answered, would neither prove nor tend to prove nor disprove any issue in this case.

A. Never anything said to me.

X-Q. 143. Was there ever any complaint made to you that your concentrate was of too low a grade?

By Mr. Kremer: Objected to for the same reasons last interposed to X-Q. 142.

A. Yes, there was, at times.

X-Q. 144. I presume there was more complaint at the beginning of your work than after you had had considerable experience with the plant; is that true?

By Mr. Kremer: Same objection as last interposed.

A. Yes.

X-Q. 145. Please describe the positions of the shafts of the agitators in the agitator boxes; that is to say, were they in the middle of the box or off to one side.

A. They were in the center.

Cross-examination closed.

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Re-Direct Examination by Mr. Kremer.

R-D. Q. 146. Was there any additional oil or acid put into the concentrates after they left the rougher and went to the cleaner?

A. That was tried for a while, but abandoned.

R-D. Q. 147. And then it was operated in what manner, with or without?

A. Without.

R-D. Q. 148. Was the overflow of concentrates regulated differently on the two machines; by that I mean the rougher and the cleaner; if so, how?

A. Yes, it was.

R-D. Q. 149. How?

A. There was a large amount of water in the concentrate coming from the rougher, and no water in the concentrate from the cleaner.

R-D. Q. 150. By that I presume that you mean no free flowing water?

A. Yes.

Re-direct examination closed.

Re-Cross Examination by Mr. Williams.

R-X Q. 151. When was the change made in abandoning the use of additional oil or acid after the concentrates left the rougher and before they entered the cleaner, in relation to the time of Mr. Nutter's visit: before or after this visit?

A. I don't remember.

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R-X Q. 152. When additional oil was put in how and where was it put in?

A. In the first agitator box in the first unit of the cleaner.

R-X Q. 153. Where was the additional acid put in?

A. At the same place.

R-X Q. 154. Was there a separate tank for this additional oil, or did the pipe run from the one tank which supplied the rougher?

A. A separate tank.

R-X Q. 155. And how were the concentrates conducted from the rougher to the cleaner?

A. By gravity and hydraulic lift, the cleaner being lower than the last unit of the rougher machine.

R-X Q. 156. And, of course, this hydraulic lift added water at this point, didn't it?

A. Yes, sir.

R-X Q. 157. Now, as to the regulation of the fluid levels in the spitzkasten of the first unit of the rougher and the spitzkasten of the second unit of the rougher, how was this brought about?

A. Regulated by a valve.

R-X Q. 158. And where was this valve located?

A. The valve was located between the bottom of the spitzkasten and the centrifugal pump.

R-X Q. 159. Was there any other connection from the spitzkasten of the first unit directly or indirectly to the spitzkasten of the second unit?

A. None.

R-X Q. 160. You have testified of regulating the

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overflow of concentrates differently in the rougher and in the cleaner. Now, how did you regulate the overflow in the cleaner?

A. By valves in the same manner as we did on the rougher.

R-X Q. 161. Then, as I understand you, the difference was due to different regulation of the valves which controlled the flow of liquid or tailings from one unit to the next; is that correct?

A. Yes, sir.

R-X Q. 162. Was there any overflow regulation from the last spitzkasten of the cleaner other than in the pipe from this spitzkasten back to the rougher?

A. There was just the regulation of the inlet and outlet of that cell by valves in the pipe.

R-X Q. 163. You have said that there was a large amount of water in the concentrate coming from the rougher. Where was the fluid level maintained in the spitzkasten of the rougher to bring this about?

A. Above the level of the overflow lip.

R-X Q. 164 Now, in the cleaner you have said there was no water in the concentrate that flowed from it. How was this accomplished as to the position of the fluid level in each spitzkasten of the cleaner?

A. It was accomplished by keeping the water level slightly below the level of the overflow lip.

Re-cross examinat~~ed~~ion closed.

Deposition closed.

JESSE C. GIBSON.

Deposition of Jesse C. Gibson.

Subscribed and sworn to before me this 1st day of April, A. D., 1912.

CHARLES H. LITTLE,
Notary Public for the State of Montana, residing at Butte, Silver Bow County, Montana. My commission expires July 6th, 1913.

It is stipulated and agreed that the further taking of testimony upon behalf of defendant may be and is adjourned to such time and place, and before such Examiner as the court may direct or as counsel herein might agree upon.

Notary's Certificate.

CERTIFICATE OF SPECIAL EXAMINER.

UNITED STATES DISTRICT COURT, DISTRICT OF MONTANA.

Minerals Separation, Limited, and Minerals Separation American Syndicate, Limited, *Complainants.* *vs.* James M. Hyde, *Defendant.*	In Equity.

State of Montana, County of Silver Bow, ss.

I, Charles H. Little, a Notary Public in and for the State of Montana, residing at Butte, Montana, hereby certify that the foregoing deposition of Jesse C. Gibson was taken before me at the office of Kremer, Sanders & Kremer, State Savings Bank Building, Butte, Montana; that said deposition of Jesse C. Gibson was taken on April the 1st, 1912; that for the purpose of taking said deposition I acted by agreement of counsel as Special Examiner under the 67th Rule in Equity as amended; that during the taking of such deposition the complainants were represented by their counsel, Henry D. Williams, Esq., and the defendant was represented by his counsel, J. Bruce Kremer, Esq.; that before said witness gave his deposition the said witness was duly sworn by me and his deposition taken down on the typewriter in the presence of counsel for both parties, and that, at the conclusion of his deposi-

Notary's Certificate.

tion, the same was signed by the witness in my presence.

I further certify that I am not of counsel for either party to this cause, nor related by blood or marriage to any member of either of the complainant corporations or the defendant, and that I am not interested directly or indirectly in the matter in controversy.

In testimony whereof, I hereunto set my hand and notarial seal this 1st day of April, 1912.

CHARLES H. LITTLE,
Notary Public in and for the State of Montana, residing at Butte, Silver Bow County, Montana. My commission expires July 6th, 1913.

Deposition of James M. Hyde.

UNITED STATES DISTRICT COURT, DISTRICT OF MONTANA.

Minerals Separation, Limited, and Minerals Separation American Syndicate, Limited, *Complainants,* *vs.* James M. Hyde, *Defendant.*	In Equity. No. 1076.

Depositions of witnesses in behalf of defendant in the above entitled suit, taken by agreement of counsel before Joseph H. Blackwood, a Notary Public in and for the District of Columbia, acting by consent of counsel ~~of~~ for both parties as Special Examiner, under the 67th Rule in Equity, as amended, at the office of Byrnes, Townsend & Brickenstein, 918 F street, N. W., Washington, D. C., beginning on Wednesday, April 24th, 1912, at 10 o'clock in the forenoon.

Appearances: Henry D. Williams, Esq., for complainants; J. Bruce Kremer, Esq., for defendant; Walter A. Scott, Esq., for defendant.

JAMES M. HYDE, a witness produced in behalf of defendant, having been duly cautioned and sworn, testified as follows:

Direct Examination by Mr. Scott.

Q. 1. Please state your name, age, residence and occupation.

Deposition of James M. Hyde.

A. James M. Hyde; 38 years; residence, Palo Alto, California; mining engineer and metallurgist.

Q. 2. Are you the defendant in this suit?

A. I am.

Q. 3. Please state briefly your education and experience in your profession.

A. I am a graduate of the department of geology and mining of the Leland Stanford, Jr., University, in which institution I was for one year instructor in assaying. I was for one year curator of the museum of the California State Mining Bureau, and for three years professor of mining and metallurgy in the University of Oregon. I have worked as a common miner, and as a mill-hand in all parts of amalgamating, concentrating, cyaniding and chlorination mills; have worked as an assayer and chemist, as superintendent of mines and mills; as consulting engineer, and valuer of mines. I have been a student of processes for the treatment of different ores for the past fifteen years, and am the inventor of an improved process for the flotation concentration of ores, which is covered by U. S. patent No. 1,022,085.

Q. 4. Have you ever had any business dealings with Minerals Separation, Limited, one of the complainants in this suit?

A. On January 18, 1910, I received the following telegram:

> "Can you come London, all expenses allowed in order to see process working and directors. If the directors are satisfied your appearance will

Deposition of James M. Hyde.

offer one thousand pounds sterling and expenses for a year in Mexico or elsewhere. Examination of properties.

"(Signed) HOOVER,
"Care Mineration."

This cable was sent to me by Mr. T. J. Hoover, who was general manager for Minerals Separation, Limited, one of the complainants. I had not heard from him for some two years' time, but was familiar, in a general way, with the business with which he was concerned, and cabled a reply, stating that I should leave for London, as requested, upon receipt of an advance sufficient to cover expenses of the trip. The advance was forwarded, and I left California about the 28th or 29th of January, and proceeded directly to London. In London, I was informed that a small private syndicate had been organized to search for mining business in Mexico, and that they would like to have me consider undertaking a search in that country, for special ventures for this syndicate. The Board of Directors were apparently satisfied that I was the proper person to undertake this work, after we had had our first meeting, for I was requested to outline a plan of campaign for the work. They immediately commenced to endeavor to persuade me to give them a contract for two years of my time, and it took me over two weeks, during which we were discussing matters and going over reports on Mexican properties, to persuade them that my determination to contract for but one year's time was final and unchangeable.

Deposition of James M. Hyde.

I stated to them the reasons which led me to consider it extremely undesirable to contract for more than one year's time, which were in part as follows: That I would not undertake any long-term contract which would require me to be separated for long periods from my family; that Sr. Ezequiel A. Chavez, assistant secretary of education for the Republic of Mexico, had requested me to hold myself in readiness to undertake, so soon as opportunity could be arranged, the outlining and development of a system of industrial education for the people of his country, and that this was an opportunity of which I should wish to avail myself, if it took material form. Further, that a year might indicate to us that it was not wise to attempt to do business together further, and that during that year I should come into possession of an inheritance which, supplementing my own earnings and savings, would permit me to operate independently, upon a modest basis. It was with a full understanding of these matters that the employment for a year's time was mutually agreed upon.

While this matter was under discussion, I visited the test works in London, and was shown the methods by larger / which small and ~~large~~ lots of ore were tested by the processes practised by the company, and also made a trip to South Wales, to witness some tests of the flotation process which was being tried out on ore which had been shipped to England from the San Francisco Del Oro mine in Mexico. These tests were not very instructive, as Mr. Hoover and the attendant in charge informed us that the results being obtained were very

unsatisfactory. Upon my return to London, I came to an agreement with the Board of Directors that I should enter their employ for one year's time, and the chairman of the company, Mr. John Ballot, addressed a letter to me dated the 2nd of March, 1910, which reads in part as follows:

"James M. Hyde, Esq.,
"62 London Wall, E. C.
"*Dear Sir:—*

"As explained to you a private syndicate has been formed in connection with my company for the special purpose of exploring the Republic of Mexico, with a view to finding mines, ores, dumps or tailings, preferably amenable to profiitable treatment by the Minerals Separation processes, and to endeavor to acquire such mines, ores, dumps or tailings, wholly or in part, if such can be done on sufficiently advantageous terms, or to secure the adoption of Minerals Separation processes by mine owners, under royalty, in cases where a direct interest cannot be acquired—and if successful, to form a larger company to handle the interests so acquired.

"To give effect to this, and after fully discussing the policy with your goodself, it has been agreed to retain you to give your services exclusively, to make the necessary investigations in Mexico, and to carry out the object and intention of the

Deposition of James M. Hyde.

> syndicate to the best of your ability on the following terms and conditions:"

Then follow the terms and conditions as shown by the letter which I now produce.

To quote further from the letter:

> "For the purpose of this understanding and to enable you to test ores on the spot, Minerals Separation will disclose to you its various processes, and give you all information in connection therewith, you undertaking to keep all such information confidential, and not to make use of any of it for any purpose except that of the syndicate, and further you undertake and agree to communicate to that company any ideas for improvement, modification or addition to the processes, mechanical or otherwise, which may occur to you, or which you may make, and such shall be the sole property of the Minerals Separation, and you will immediately, or whenever called upon, sign all documents necessary to protect the same by patent, if so desired, and to convey the title to that company by assignment or otherwise."

At the testing works, I was shown the bottle test referred to by Mr. Nutter, in his testimony in this suit, which I recognize to be the exact test given by Alcide Froment in his British patent No. 12,778, accepted on June 4, 1903; and also certain tests which were conducted by agitating finely pulverized ore, water, sul-

Deposition of James M. Hyde.

furic acid and some oily substance, in a rectangular wooden box having two glass sides, through which the operations being carried on within could be observed. This apparatus was used as follows:

Ore, water, a small amount of sulphuric acid, and a small amount of some oily substance, were agitated together by an impeller, rotated upon a vertical shaft, suspended from above and without the vessel. When the agitation was completed, the mass was allowed to come to rest, when a considerable amount of floating mineral could be seen upon the surface in the form of a froth. The material was then reagitated while the contents of the vessel were drawn out through an aperture at the bottom, and spread out upon the apron-plate of an overflow settling box, the oiled mineral matter floating off as a surface film while the gangue and some of the metalliferous mineral sank to the bottom and was drawn off and retreated upon a device similar to the one from which it was drawn.

Mr. T. J. Hoover, consulting metallurgist and general manager of the company, told me that this test did not represent the processes as actually operated by the company, but was the nearest approach to it which they had been able to devise on a small scale, and asked me to co-operate with him in devising a form of apparatus which would give results duplicating those obtained in the frothing process as developed in Australia, so that I might have a machine with me by which could be duplicated the results to be expected of the frothing process, as developed in Australia.

Deposition of James M. Hyde.

Together, we designed a machine similar to and probably the same as the machine referred to as the slide test machine by Dr. Chandler and Mr. Nutter, in their testimony. I had several of these machines built in London and remained in the city long enough to develop a system of tests by the use of this apparatus and to instruct Mr. Wilkinson, an attache of Minerals Separation, Limited, in the use of this apparatus.

I proceeded to the United States and thence to Mexico, and devoted the year to a search for such properties as might be worked to a profit by the Mexican Syndicate.

> By Mr. Williams: It being noted that the telegram of Jan. 18, 1910, referred to by the witness, was a code telegram, it is requested that it be marked for identification, subject to production upon request.
>
> It is also requested that the letter dated March 2, 1910, referred to by the witness, be marked for identification, subject to production upon request.
>
> By Mr. Kremer: The telegram and letter referred to may be marked for identification and may be produced upon request of counsel.

Q. 5. What was the principal difference in the operation of this small experimental machine which was in use when you went to London, and the one which you and Mr. Hoover designed?

A. There are two methods by which particles of metalliferous mineral which has been covered by a bare film of oil or some oily substance may be made to float

Deposition of James M. Hyde.

upon the surface of the water. The first of these is by what is called surface tension—when the mineral particles float upon the surface of the water in a layer or film which is not more than one mineral particle in

P. 1381, L. 6, insert "water. A second method is by attachment of these mineral particles around gas bubbles which fioat upon" after "upon"

which had been agitated in the agitating box was discharged upon the apron of the overflow settling box, the oiled mineral particles flowing down the inclined apron were exposed to air and floated off as a film upon the surface of the water. This was necessitated by the method of discharging the agitated matter through a small opening upon the surface above the water. The apparatus designed by Mr. Hoover and myself was so arranged that when a material had been sufficiently agitated to oil the metalliferous matter, agitation ceased, the oiled mineral matter with gas bubbles attached floated and was removed as a floating froth by sliding off the top half of the material and discharging its contents into some receptacle.

Q. 6. Did you complete your year's employment with the Minerals Separation, Limited, as you agreed to?

A. I did.

Q. 7. What did you do in the practice of your profession immediately after leaving their employ?

A. Immediately after leaving the employ of Minerals Separation, Limited, I accepted an appointment as consulting engineer for the Oroya Exploration

Deposition of James M. Hyde.

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Deposition of James M. Hyde.

upon the surface of the water. The first of these is by what is called surface tension—when the mineral particles float upon the surface of the water in a layer or film which is not more than one mineral particle in thickness or depth, as a greased needle will float upon the surface. The apparatus as used in London, when I arrived there, was so arranged that when the matter which had been agitated in the agitating box was discharged upon the apron of the overflow settling box, the oiled mineral particles flowing down the inclined apron were exposed to air and floated off as a film upon the surface of the water. This was necessitated by the method of discharging the agitated matter through a small opening upon the surface above the water. The apparatus designed by Mr. Hoover and myself was so arranged that when a material had been sufficiently agitated to oil the metalliferous matter, agitation ceased, the oiled mineral matter with gas bubbles attached floated and was removed as a floating froth by sliding off the top half of the material and discharging its contents into some receptacle.

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A. Immediately after leaving the employ of Minerals Separation, Limited, I accepted an appointment as consulting engineer for the Oroya Exploration

Company, with offices at No. 1 London Wall Bldgs., London, and prepared to stay in London for some time, giving my time to consulting engineering work, etc. I cabled to the United States to have my wife join me, and she replied that it would be unwise for her to do so for some time, on account of the condition of the health of our only child. I therefore planned to return to the United States at the earliest opportunity.

Q. 8. What knowledge did you have of oil flotation processes at the time you entered the employ of Minerals Separation, Limited?

A. I had for years made a close study of all that appeared in the technical press with regard to new methods for the treatment of ores, and had read everything which had appeared upon this subject in the Engineering & Mining Journal, Mining and Scientific Press, and other current literature, and was thus familiar with the work done by the Elmores and others, and by the group who were working in the Broken Hill field.

Q. 9. At the time you entered the employ of Minerals Separation, Limited, or while so employed, did you make any study of the patent situation from the legal point of view?

A. As my time was devoted to the search for material which could be acquired by purchase, lease or otherwise, I gave very little study to the legal phases of the situation. I remember having read some part of the record of the suit filed against Minerals Separation, Limited, by the Elmores.

Deposition of James M. Hyde.

Q. 10. Did your duties while employed by the Minerals Separation, Limited, require you to be conversant with the patent protection which they might have or were going to have?

A. They did not. They made very broad claims to me as possessing monopolistic rights for the use of all flotation processes which involved the use of small amounts of oil, but, as I was specifically warned by them against seeking royalty business, except as a last resort, I never had occasion to prepare myself to defend their rights in matters involving infringement of patents, etc.

Q. 11. After leaving the employ of Minerals Separation, Limited, did you investigate any patents bearing upon flotation processes, and, if so, when and to what extent?

A. After leaving the employ of Minerals Separation, Limited, in order to assure myself as to the actual status of the patent situation in regard to flotation processes, I read over all of the patents relating to this subject which I could acquire or obtain access to, and made as careful study as possible of the subject-matter covered by them.

Q. 12. What conclusion did you arrive at as a result of the study of these patents?

Objected to by Mr. Williams, as incompetent.

A. I arrived at the conclusion that the only patents which were significant, which had ever been granted upon the subject, so far as I could learn, were the American patent, granted to Carrie J. Everson, No.

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348,157; the British patent No. 12,778, accepted June 4, 1903, granted to Alcide Froment, and the Elmore vacuum process patent No. 826,411.

The Everson patent referred to was important as broadly disclosing the preferential oiling of mineral particles by oils and fats and derivatives thereof; the intensifying of this selective action by the use of an acid; and the possibility of separating the particles of metalliferous minerals from the gangue, either by building them up into an agglomerated mass, which will not float, or by causing them to float as the result of oiling and agitation. The Froment patent disclosed the fact that metalliferous mineral particles, which have been slightly oiled, will attach themselves to and can be floated by gas-bubbles. The Elmore patent cited is important as showing an ingenious method by which gas-bubble flotation can be effected. To my mind, the Everson and Froment patents disclose the whole basis upon which the art of flotation concentration has been developed.

By Mr. Williams: Reference to the Elmore vacuum process patent No. 826,411, is objected to as incompetent, for the reason that this patent is not set up in the answer as an alleged anticipation, and it is further noted that it appears upon the face of the Elmore patent that the application for this patent was filed July 10, 1905, whereas the application for the patent in suit, as appears upon the face of that patent, was filed prior thereto, on May 29, 1905.

Deposition of James M. Hyde.

Q. 13. You have referred to a testing apparatus in use by Minerals Separation, Limited, prior to the time you and Mr. Hoover designed the slide test machine. Were you told what the purpose was of having the test machine of the type used before the making of the slide machine?

A. Mr. Hoover informed me that when he went into the employ of Minerals Separation, they were attempting to carry on a flotation process by the use of an apparatus consisting of an agitator or series of agitators similar in type to the one illustrated in the cut shown in the patent in suit, the ore treated being first agitated in these vessels and then delivered through a pipe to an overflow settling box substantially as in the test apparatus which I have referred to as having been shown to me in London, which test machine therefore practically duplicated the operations which were attempted upon a commercial scale in the device just referred to. Consequently, this test machine would give a fair idea of what could be expected of the type of treatment machine which it substantially duplicated.

By Mr. Williams: The answer is objected to as hearsay and incompetent, and notice is given for a motion to strike it out.

Q. 14. Did you receive any instructions from those connected with Minerals Separation, Limited, regarding the practice of any oil flotation process?

A. The only definite instruction given me was that a preliminary idea could be obtained of the results obtainable in the treatment of an ore by making the bottle

test, which has previously been referred to, and by carrying out a series of tests in the slide machine, in order to determine what oily substance would be best adapted for use with a particular ore. I was not instructed in detail with regard to the use of large testing machines further than that in all cases it was necessary to run varying the conditions as to amount of oil and acid used until such quantities were determined upon as gave the best results.

Q. 15. Did the Minerals Separation, Limited, or those connected with it, instruct you that in actual commercial operations you were to use apparatus like that shown in the patent upon which this suit is based?

A. I was informed by the engineer of the company that apparatus of the type of that shown in the illustration of the patent in suit had proven unsatisfactory and had been abandoned.

By Mr. Williams: The answer is objected to as hearsay and incompetent, and notice is given for a motion to strike it out.

Q. 16. While in the employ of Minerals Separation, Limited, did you see their process or any of their processes carried out upon a practical commercial scale?

A. I did not see any commercial operations carried on in which any process to which they claimed ownership was used on a commercial scale.

Q. 17. When your year of employment by Minerals Separation, Limited, came to a close were there any negotiations looking toward a continuance of your connection with that company?

Deposition of James M. Hyde.

A. Toward the end of my year of work, I received a communication from the chairman of the company asking me to undertake work outside of the Republic of Mexico, and work of such a nature that it would require more time than was left in the one year which I had contracted to give to their service. I therefore cabled to him reminding him that I had refused to contract for more than one year's time and asking where and when he proposed to discuss with me the question of further service. In reply to this telegram, I was requested to leave New York for London at an early date, and did so, arriving in London a day or two before Christmas day of 1910. I was asked to outline a plan upon which we could work together for a greater length of time, being told that an American Syndicate had been formed to carry out such a search for business upon the whole American continent, as had been undertaken in Mexico by the Mexican Syndicate. I submitted a memorandum outlining such plan which was considered by the members of the board of directors and discussed with me in particular by Mr. Francis Gibbs, Jr., one of the directors. A discussion of this matter was going on, with all probability that I should enter into another contract with the firm, when I determined that it was not wise for me to continue longer with them, withdrew the memorandum referred to, and handed in a letter formally severing my connection with the firm.

By Mr. Williams: The entire answer is objected to as incompetent, and notice given of a

motion to strike it out. It is further noted that the communications referred to, the memorandum outlining the plan of the witness referred to, and the letter severing connection with Minerals Separation, Limited, referred to, are apparently capable of production, either by originals or full copy thereof, and therefore all reference thereto and attempt to epitomize the contents thereof, are secondary and incompetent, and in the absence of the best evidence as to these matters, notice is given of a motion to strike out this answer.

Q. 18. Have you the several letters and other communications to which you have referred?

A. I have the originals of communications received by me and copies of communications presented by me to the company. Also a letter, which would complete the series, in answer to my letter of resignation.

By Mr. Scott: The letters, cablegrams and copies referred to by the witness, in his answers to the two preceding questions will be marked for identification, subject to production upon request.

Q. 19. Was there any particular reason that influenced you in concluding not to continue your connection with Minerals Separation, Limited, after the expiration of the year you had agreed to work for them?

A. There was.

Q. 20. What was the reason?

A. Mr. T. J. Hoover, who had been acting as consulting engineer for Minerals Separation and occuping an office with them, decided to move to another office

Deposition of James M. Hyde.

and devote but a portion of his time to the firm after the 1st of January, 1911. It was understood when he moved from Minerals Separation's office that the company desired that he should continue to act in a consulting capacity for them, and that he was willing to do so, upon certain terms and considerations. When he moved to the new quarters in which he established himself, he moved hurriedly, at the request of Dr. Gregory of the Board of Directors that he give him his office room as early as possible, and in moving, took to his new office a case containing a file of papers which included the accumulation of his own correspondence and notes for years, and also such reports as had been handed in to him while acting as consulting engineer for Minerals Separation, and which it would be necessary for him to have at hand, if he continued to act in that capacity. After he had removed his furniture, etc., from the offices occupied by Minerals Separation, Limited, a discussion arose between himself and the company as to the terms on which he was to continue to act in a consulting capacity for them, and taking offense at the terms which he proposed, the directors of the company, by telephone, demanded that he immediately turn over to them all documents relating to their business which were in his possession; as these were scattered through a great mass of personal material, it would be impossible to remove them at once and he replied that he was leaving for Russia, would not have time to attend to the matter before he left, but would do so immediately upon his return. The officers of the company, know-

ing that he was out of the city, brought an injunction against him, to prevent him from turning over the "documents and secret information of great value" to anybody other than themselves, and sent officers of the law to his house to serve such notice upon him. Although this was an *ex parte* proceeding, a type of action which almost never is allowed to appear in the public press in England, the two great financial dailies of the country contained accounts of the matter the next morning. During Mr. Hoover's absence from the city I acted in his behalf with the Board of Directors, endeavoring to protect his interests and show them how unnecessary and unreasonable was the action which they had taken. In one of my conversations with one of the directors, Mr. Curle, he informed me in the presence of Dr. Gregory, also of the Board of Directors, that Mr. Hoover had been punished enough. I told him at the time that I was certain that that was the motive which had prompted the action which had been taken.

This whole affair led me to conclude that it was unsafe and unwise to longer associate myself with people who would make such an unnecessary and unwarranted attack upon the engineer to whom more than to anyone else was due the success of such operations as they had been engaged in.

By Mr. Williams: It now appearing that the reason called for is not a fact capable of proof in the manner stated, notice is given of a motion to strike out the entire answer, as incompetent.

Deposition of James M. Hyde.

Q. 21. Did you ever state to Mr. Edward H. Nutter that you had accepted employment by Minerals Separation, Limited, for a year only, so that you would be free at the end of that period to make a more favorable contract with the company for your further services or else to make use of your knowledge of flotation concentration for your own purposes?

A. In my answer to Q. 4 I have stated the reasons for not entering into a longer contract, which were my real reasons. I was never actuated by such a motive as referred to by Mr. Nutter, and never stated to him or to anyone else that I was.

Q. 22. How soon did you return to the United States after the expiration of your employment by Minerals Separation, Limited, and what did you do immediately after reaching the United States?

A. About the first of March, 1911, Mr. H. C. Hoover, with whom I was associated in the matter of the Oroya Exploration Company, decided to make a hurried trip to the United States. As my family could not join me in London, I decided to return to the United States with him, and did so, arriving in New York early in March. When we arrived in New York. Mr. Chester Beatty, with whom Mr. H. C. Hoover was associated in a number of ventures, informed him that he was about to send Mr. Kuehn to Butte, to make an examination of the Butte & Superior Copper Company's property, for Hayden, Stone & Company, who were considering buying a large part of the company's bonds. Mr. Beatty and Mr. H. C. Hoover had previ-

ously considered participating in financing this company in connection with Hayden, Stone & Company, I believe, and Mr. Kuehn had made a previous examination of the property. As Mr. Beatty and Mr. H. C. Hoover were offered a participation in a bond issue which was being considered, Mr. H. C. Hoover suggested that as I had nothing definite on hand, they would like to have me go along and assist Mr. Kuehn in preparing a report on the property, and also make some tests upon the ore, in order to determine what was the best method by which it could be treated, and what results could be expected, so that they might know what value to ascribe to the property in making their estimates which would determine whether or not they would participate in the bond issue. I went to Butte with Mr. Kuehn, assisted him in gathering all of the data necessary to make the report and in making the computations upon which a report should be based. No one connected with the Butte & Superior Company, was, to my knowledge, acquainted with the fact that I had any knowledge of ore concentration processes until this examination was completed. At the completion of the examination, Mr. R. M. Atwater, general manager of the company, arrived in Butte, to discuss his findings with Mr. Kuehn. When I was introduced to him, he told me that he had met H. C. Hoover in New York, and that Hoover had told him that I was on the examination and was familiar with concentration processes.

Deposition of James M. Hyde.

BY MR. WILLIAMS: Notice is given for motion to strike out the first sentence of the answer, as incompetent, in that it states a conclusion arrived at by a third party.

A like notice is given of motion to strike out the third sentence of the answer as hearsay and incompetent.

A like notice is given as to the fourth and fifth sentences.

A like notice is also given as to the last sentence of the answer.

Q. 23. What caused you to first apply flotation treatment to the ore of the Butte & Superior Copper Company, either experimentally or otherwise?

A. Mr. H. C. Hoover asked me to determine for him if the ore was amenable to treatment by a flotation process.

BY MR. WILLIAMS: Objected to as relating alleged statements made by a third party, and notice is given of a motion to strike out as incompetent.

Q. 24. What did you do to ascertain whether the Butte & Superior ore was amenable to flotation treatment?

A. I had a local foundry in Butte make a test machine for me of substantially the same type as the slide machine which we perfected in London, and with this machine tested the ore.

Q. 25. Did you make any report of the result of your test, and if so, to whom?

Deposition of James M. Hyde.

A. I reported the results of my tests direct to Mr. H. C. Hoover.

Q. 26. Did anyone else approach you for information on the treatment of Butte & Superior ores by the flotation process?

A. Mr. R. M. Atwater, the manager of the property, asked me to report the results of my tests to him, and Mr. Kuehn, who had made an examination, wired to me from New York, asking me to send him the results of my tests. To both I replied that my results would be reported only to Mr. H. C. Hoover, as I did not know what were the details of the negotiations which he had on with the company.

By Mr. Williams: Notice is given of a motion to strike from the answer the reference to communications, unless the original communications are produced, with a further reservation that the communications appear to be fundamentally incompetent.

Q. 27. Did you, at a later date, make any report to the Butte & Superior Copper Company regarding flotation treatment of its ores?

A. I did.

Q. 28. What was the result, if any, of a report which you so made?

A. I was requested by the company to install an experimental machine for them at Basin, Montana.

Q. 29. Did you install such a machine?

A. I supervised the installation of such a machine.

Q. 30. About when was this machine first operated?

A. About the first of August, 1911.

Q. 31. Is this machine still in existence?

A. It is not.

Q. 32. How long was it operated?

A. Intermittently for probably between one and two months.

Q. 33. Will you explain how it happened to be destroyed?

A. After this test machine had proven that the new process which I had worked out could be successfully employed, a larger machine was built and this one was abandoned. During my absence from the plant, the experimental machine was dismantled, as it was desirable to send parts of it to Butte, to be used in equipping the woodworking shop of the Butte & Superior Mine, and the Basin Reduction Company, owners of the mill at Basin, were desirous to have the room occupied by the test machine, which was loaned by them temporarily, made again available for their uses.

> BY MR. WILLIAMS: The part of the answer commencing with "as it was desirable" to the end of the answer being clearly incompetent, notice is given of a motion to strike it out.

Q. 34. Will you describe the construction and operation of the plant built at Basin, and started in operation about Aug. 1, 1911?

A. I have prepared from memory a rough sketch of this plant, which is lettered, and to which I will refer in describing the plant. The plant as installed and used for experimental work at Basin consisted of two

Deposition of James M. Hyde.

parts, a machine known to the operators as a rougher machine, and generally designated on the sketch as R. M., and a secondary or cleaning machine, designated on the sketch as C. M. The rougher machine, consisted of six agitating compartments and three overflow settling boxes. Five of these agitating compartments were built together in the form of a rectangular box divided by partitions into compartments. To this box were attached two of the overflow settling boxes. The remaining portion of the rougher machine consisted of one rectangular agitating compartment, connected with an overflow settling box. In each of the agitating compartments an impeller suspended and attached to a vertical shaft was provided to act as an agitator. The cleaner machine consisted of four agitating compartments and two overflow settling boxes. Three of the agitating compartments were built together in the form of a rectangular box, divided into three sections by partitions. To this box was attached one of the overflow settling boxes. The remaining portion of the cleaning machine consisted of one rectangular agitating compartment connected with an overflow settling box. In connection with the concentration machine proper were used two pulp-thickening tanks, in which the pulp to be treated was separated from as much clear or nearly clear water as possible, in order to prepare it for flotation treatment.

Referring to the sketch, I will trace the passage of the ore through the machine and pulp-thickeners while being treated. The material to be treated, which con-

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sisted of fine portions of the ore removed by classifiers from that portion of the ore which was treated by other devices, flowed to the pulp thickeners through the thin pulp launder marked T. P. L. to the pulp-thickener designated as P. T. A small amount of sulfuric acid was added to the pulp as it flowed to the pulp-thickener from the acid-pot, A. P., by means of a pipe, the flow being regulated by the acid-valve A. V. The thickened portion of the pulp, which was to serve as feed for the flotation machine, was drawn off from the bottom of the pulp-thickeners by the feed-valves F. V. and F. V.′, and flowed to the flotation machine through the feed launder F. L. The clear, or nearly clear, water flowed off to waste over the end of the pulp-thickener marked C. W. O. The feed launder F. L. discharged the ore to be treated into the agitation compartment A^1. Into this compartment live steam was discharged through the steam-pipe S. P., and red oil was fed from the oil-pipe O. P. The pulp, after being agitated in A^1, flowed through an aperture into A^2, in which it was further agitated, and from which it flowed through an aperature into A^3, in which it was further agitated. From A^3 the pulp flowed through a practically square opening into the settling box designated as S. $B.^1$. This settling box was so attached to the box containing the agitating compartments that the partition dividing A^3 from A^4 was opposite the center of the settling box. Over the discharge lip of the settling box S. $B.^1$, floating metalliferous minerals with considerable free-flowing water containing gangue minerals over-

flowed continuously into the launder marked R. C. L. That portion of the pulp which was not drawn over the discharge lip into the concentrates launder flowed from the overflow settling box through the valve V to a pipe leading to a pump marked Pump 1, by which it was elevated and discharged into the agitating compartment A^4, in which it was agitated further, and from which it flowed into the agitating compartment A^5 for further agitation. From A^5 it flowed through the square opening into the settling box S. B.^{2}, from the overflow lip of which the floating metalliferous matter with considerable free-flowing water containing gangue minerals was continuously discharged into the rough concentrate's launder. Through the valve V′ that portion of the pulp which was to be further treated was discharged into a pipe, through which, by means of an hydraulic elevator and by force of gravity, it flowed into the agitating compartment A^6, from which, after agitation, it was discharged through a practically square aperture into the overflow settling box S. B.^{3}, from the discharge lip of which was discharged the last portion of the concentrate recovered from the ore, together with a considerable amount of free-flowing water carrying gangue minerals in suspension. By means of the valve V″, the tailings were discharged to waste. The concentrates drawn off over the discharge lips of the settling boxes of the rougher machine flowed to a pipe, through which they were forced into the first agitator compartment A^7 of the cleaner machine by an hydraulic elevator. After agitation in A^7 they passed through an opening into A^8, and

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thence on to A^9; being agitated in each of these compartments, and flowed through a practically square opening into the settling box S. B. ^{4}. Upon the surface of the water in this overflow settling box, the concentrates piled up as a tenacious froth 3 or 4 inches thick. The water in this settling box was maintained at such a level by the manipulation of the valve V''' that no free-flowing water overflowed from it, but the concentrates piled up and flowed over the discharge lip as a thick mass into the clean concentrate's launder C. C. L. A portion of the material which was not drawn over the discharge lip was passed on to the agitating compartment A^{10} through the valve V''', and a pipe through which it was forced by an hydraulic elevator. After being reagitated in A^{10}, the material passed through a practically square opening into the settling box S. B.^{5}. When the amount of concentrates forming upon the surface of the water in S. B.^{5} was sufficient to allow the semi-dry concentrates to be drawn off over the discharge lip without any free-flowing water, they were so drawn off as from S. B.^{4}. When the amount forming was too small to allow this, no concentrates were drawn off over the discharge lip, the whole content of the machine being discharged through the valve V^4 into a pipe, through which it was forced by a steam jet to pump 1 and returned to agitating compartment A^4 for further treatment. The concentrates produced by the cleaner machine flowed through a pipe to pump 2, by which they were discharged into the shipping bin.

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BY MR. SCOTT: The sketch referred to by the witness is offered in evidence, and is designated as "Defendant's Exhibit Hyde Sketch of Experimental Machine."

Adjourned until Thursday, April 25, 1912, at 10 A. M., at the same place.

Met pursuant to adjournment. Present, counsel as before.

Direct examination of James M. Hyde continued.

Q. 35. In operating the experimental machine which you have referred to, how did you determine how much oil and acid to use?

A. The amounts to use were at all times determined by an observation of the results obtained and by varying the flow of acid and oil in such a way as to give what were apparently the best results obtainable.

Q. 36. Have you ever found any better means of regulating the amount of acid and oil than by an observation of the results secured?

A. I have never found any other means which can be made use of.

Q. 37. Did you ever see Mr. Edward H. Nutter in Montana?

A. I have met Mr. Edward H. Nutter in Montana on two different occasions, or rather at two different periods. While engaged in making the examination of the Butte & Superior property with Mr. Kuehn, I met Mr. Nutter in Butte on a number of occasions, and later met him at Basin.

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Q. 38. At the times that you met Mr. Nutter at Butte and Basin, was he there, as you understood, as a representative of Minerals Separation, Limited, or Minerals Separation American Syndicate, Limited?

A. On both occasions, he informed me that he was.

Q. 39. You have stated that you at first refused to make a report to the Butte & Superior Company regarding the treatment of their ore, but that you finally did make such a report. What occurred to change your attitude in this matter?

A. I received word from Mr. H. C. Hoover that he was not to participate in taking up the bonds to be issued by the Butte & Superior Copper Company, that consequently he was not to be considered in the matter further. I was informed by Mr. R. M. Atwater, general manager of the Butte & Superior Copper Company, that his company had discussed with Mr. Nutter the matter of having Minerals Separation or the Minerals Separation American Syndicate take up the matter of the treatment of the Butte & Superior ores, but he had decided that it would be impossible for them to do business together. He requested me to test the ore and to tell them what could be done in the matter of treating it, and I agreed to make a report upon the matter to them.

Q. 40. When in England, in the employ of Minerals Separation, Limited, did you witness any tests made with a large testing apparatus owned by Minerals Separation?

A. I saw the tests which have previously been referred to as being made in South Wales. The large test machine in the London works was not being used at the

time of my first visit to England, because of alterations which were being made in the plant. During the period of my second visit to England tests were being carried on in a special machine devised by Mr. Nutter, which machine I saw in operation one or more times, but I was informed that its results were not entirely satisfactory.

Q. 41. Are Mr. H. C. Hoover and Mr. T. J. Hoover related to each other?

A. They are brothers.

Q. 42. How long have you known them?

A. I have known Mr. H. C. Hoover since 1891 or 1892, and Mr. T. J. Hoover quite intimately since 1897.

Q. 43. You have referred to a U. S. patent upon a flotation process. When and how did you come to invent the process described in this patent?

A. I take it that you refer to U. S. patent 1,022,085, and shall formulate my answer accordingly.

While engaged in making tests upon small quantities of the ore of the Butte & Superior Copper Company in the small test apparatus which I had made at the foundry in Butte I was surprised to find that the concentrates obtained were not of as high a grade as I had anticipated from a careful study of the ore. I therefore examined the concentrates and found that they contained an apparently considerable amount of free gangue particles. The thought occurred to me that if the froth which was first formed was retreated by itself, it would be possible to disentangle and drop out a considerable portion of this worthless material. I therefore took the froths obtained from the treatment of a portion of the ore and after

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cleaning out the small test machine returned these froths to the machine, together with a sufficient amount of water, and reagitated the mass thoroughly. The bulk of the metalliferous mineral again floated and, upon assay, was found to be of higher grade than the concentrates which had been produced by the procedure which I had previously followed. I followed this matter up, and found that whereas the concentrates produced without retreatment would contain from 48 to 51 per cent. of zinc, it was possible to raise the grade by retreatment in the small test machine to as high as 55 per cent. Consequently, when I came to build a test machine at Basin, I planned for a machine consisting of a rougher and cleaner, and planned to use the rougher to make as complete a recovery as possible, and the cleaner to raise the grade of the concentrates as high as possible.

When this machine was installed it was soon apparent that the best way to achieve the results desired was to maintain such an overflow of concentrates and free-flowing water over the discharge lip of the overflow settling boxes of the rougher as would insure the complete and rapid removal of all metalliferous mineral matter which rose to the surface of the water. This involved the overflow with the concentrates of a considerable amount of suspended gangue matter. The concentrates on the surface of the overflow settling boxes of the rougher machine were usually thin and light colored. It was found possible to pile up the concentrates upon the surface of the water in the overflow settling boxes of the cleaner machine to such a depth that the water-level could be

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kept so low that there was no free flow of water over the discharge lip but a constant or intermittent sloughing over of a thick froth of cleaned concentrates. It was soon apparent that the tailings resulting from the cleaning operation were too valuable to be thrown away and an arrangement was consequently made by which they could be carried back to the rougher machine and further treated.

As it was found very difficult under the conditions met at the mill to produce a pulp sufficiently thick to be advantageously treated, the thought occurred to me that sulfuric acid might advantageously be made to act as a coagulant of the slimes in the pulp-thickener, and thereby perform a useful and added function. This was tried and was found successful. The process as covered by the patent was therefore largely developed in the course of these experimental operations, the matters of manipulation, etc., being learned during the first few days in which we worked.

Q. 44. What is the composition of the ore of the Butte & Superior mine which you have treated by a flotation process of separation?

A. The ore varies so much in its content of its various constituents that it is impossible for me to give you a chemical analysis which would be typical of the whole mine. Mineralogically, the ore consists of zinc blende, a small amount of galena, varying amounts of pyrite and copper minerals, whcih are usually very small in quantity, quartz, altered granite, in which most of the felspars are kaolinized, and rhodonite and rhodochrosite

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(respectively the silicate and carbonate of manganese). The principal value of the ore is due to its content of blende or zinc sulfid.

Q. 45. In your experiments with the Butte & Superior ores have you made any observations of the quantity of oleic acid or other oil used in different experiments, and if so, with what result?

A. I have experimented in my small test machine, using 500-gram charges of ore with amounts of oil varying from .6 of 1 cc. to 9 cc., getting very satisfactory results with both the smaller and larger amount of oil, the oil referred to being the impure oleic acid or red oil used in the experimental plant at Basin.

A typical test with the use of a very small amount of oil gave results as follows: The pulp treated was a sample of ore from the mill which assayed 23.3 per cent. zinc; the concentrates obtained from treating a 500-gram portion of this ore weighed 204.9 grams and contained 52 per cent. of zinc; the tailings weighed 283.5 grams and contained 2.2 per cent. of zinc. This test was carried out in the slide test machine, using 2 cc. of a 50 per cent. solution of sulfuric acid and .65 cc. of oleic acid. The actual recovery of zinc in this case amounted to 91.4 per cent. As the specific gravity of the impure oleic acid used is approximately .9, the actual weight of impure oleic acid used was .585 gram. This is equivalent to 2.34 pounds per ton of ore.

In a test in which 500 grams of ore containing 20.3 per cent. of zinc was treated in the small test machine with 9 cc. of oleic acid, 1 cc. of concentrated surfuric acid

and approximately 1700 cc. of water at a temperature of 78° Fahrenheit, 217 grams of concentrates containing 46.5 per cent of zinc were obtained, and 283 grams of tailings containing .6 of 1 per cent. of zinc. The weight of impure oleic acid used in this case was 8.1 grams, equal to a rate of 32.4 pounds per ton of ore. This is equal to 1.62 per cent. on the weight of the ore or 5.3 per cent. of the weight of the metalliferous mineral contained in the ore. The percentage of recovery of zinc in this test amounted to 99.4 per cent. as figured from the weight of concentrates and their assay value and as 98.4 per cent. when figured by subtracting the total zinc content of the tailings from the total zinc content of the portion of ore treated.

All assays quoted by me in discussing these tests were made by W. R. Hocking, of Butte, Montana.

I have tested the ore similarly with cotton-seed oil, using a sample which I obtained from the Fair Drug Company, of Butte, Montana, and getting phenomenally high recoveries with amounts varying from .27 of a gram to 18 grams per charge of 500 grams of ore or through a range of from 1.08 to 72 pounds per ton of ore.

Using .3 of 1 cc., or .27 gram, of cotton-seed oil in treating a 500-gram charge of ore containing 21.3 per cent. of zinc, I obtained concentrates assaying 50.6 per cent. zinc and tailings assaying 1.3 per cent zinc. The percentage of recovery as figured by formula, was 96.3 per cent.

Using 5cc., or 4.5 grams, of cotton-seed oil in treating 500 grams of ore of the same lot, I obtained concentrates

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containing 45.4 per cent. zinc and tailings containing .8 of 1 per cent. of zinc, the indicated recovery being 96.5 per cent.

Using 10 cc., or 9 grams, of cotton-seed oil in treating 500 grams of ore of the same lot, I obtained concentrates containing 49.5 per cent. zinc and tailings containing .7 of 1 per cent. of zinc, the indicated recovery being 98.1 per cent. The amount of oil used in this case was equal to 5.6 per cent. of the weight of metalliferous mineral present in the parcel of ore.

Using 20 cc., or 18 grams, of cotton-seed oil in treating 500 grams of ore of the same lot, I obtained concentrates assaying 51.5 per cent. of zinc, tailings assaying 1 per cent. of zinc and an indicated recovery of 97.2 per cent. The amount of oil used in this test was equal to 11.2 per cent. of the weight of metalliferous minerals in the ore treated.

All of these tests with cotton-seed oil were made upon a sample of ore containing 21.3 per cent. of zinc. In each test 1 cc. of pure sulfuric acid was used, and, in all cases, the concentrates were recovered as a froth.

> By Mr. Williams: It is noted that the tests above described by the witness not having been made in the presence of opposing parties, the observations and conclusions of the witness are objected to as not the best evidence, unless an opportunity is afforded to complainants to repeat these experiments by supplying the complainants with sufficient quantities of the ores used in the conditions in which they were used in these experiments, and also, if

necessary, of the other reagents. With this reservation, no objection is made to the assay figures upon the ground that the man who made the assays is not produced as a witness.

Q. 46. About how much rhodochrosite does the material fed to the flotation plant at Butte contain?

A. I have never determined what the amount is.

Q. 47. Why did you use oleic acid in the test in the experimental machine at Basin in preference to other oily reagents?

A. When I commenced to test the Butte & Superior ore I investigated the sources of oil supply which were available. I learned that the only oil being produced anywhere in the vicinity was produced by Charles T. Perry & Company, of Helena, Montana, at their soap and candle factory. I obtained samples of the material which they produced and marketed under the name of red oil and tested the same. I also obtained from the agency of the Continental Oil Company in Butte samples of various petroleum oils and from Armour & Company, samples of various animal oils. I determined that Perry's red oil was more satisfactory than other materials available, and therefore made use of it. It is the only oil produced in the Rocky Mountain region, with the single exception of some petroleum products, which do not give as commercially successful results.

Q. 48. In the operation of the experimental machine at Basin, was there any evolution of gas from the pulp during its treatment?

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A. Both in the vicinity of the pulp-thickeners and the flotation machine, a decided odor of hydrogen sulfid was evident.

Q. 49. To what did you attribute the evolution of hydrogen sulfid?

A. I attributed the evolution of hydrogen sulfid to the reaction of sulfuric acid upon the very finely-divided blend or zinc sulfid in the ore being treated. This odor is frequently very pronounced immediately after adding sulfuric acid when making tests in the small slide test machine, and was so pronounced around the large experimental machine that it was commented upon by the workmen.

Q. 50. Is the odor of hydrogen sulfid of such a character or quality that you can definitely identify it thereby?

A. The odor of hydrogen sulfid is of so definite a nature that it can very easily be identified. I am so familiar with it, from the use of this gas in chemical work, that I think it would be impossible for me to mistake any other odor for the odor of this gas.

Q. 51. In your work with the flotation process, as you have described it, have you noted any evidence of the evolution of any other gas than hydrogen sulfid?

A. In all of the small tests which I have made in the slime machine, there has been a loss of a certain amount of ore as indicated by adding together the weight of the concentrates and tailings produced and comparing this sum with the weight of the amount of ore treated. This loss amounts to several grams, even

when the greatest care is used in manipulation to avoid mechanical losses, and it has seemed to me that to account for it, it must be assumed that some portion of the ore is dissolved in the very dilute sulfuric acid solution in which the pulp is treated. The most soluble constituent of the Butte & Superior ore is the rhodochrosite or manganese carbonate. If any of this were dissolved, carbon dioxide would be evolved.

Q. 51*a*. According to your observations of the Butte & Superior ore, is the amount of manganese carbonate present sufficient to account for the loss or difference in weight between the material treated and the weight of the concentrates and tailings?

A. I have no definite data on the matter. I have examined many car-loads of ore as received at the mill and have never seen one which did not contain rhodochrosite, which is very conspicuous because of its pink color. This mineral is always a conspicuous constituent of the jig-concentrates, and it and the allied manganese mineral, rhodonite, are undoubtedly responsible for the 2.99 per cent. of manganese found by Dr. Chandler in zinc concentrates said to be from Basin.

Q. 52. In what physical condition is the oleic acid delivered to you by Perry & Company?

A. It comes to us in drums or barrels and is always in a solid or semi-solid condition. I have never seen a barrel opened in which it was sufficiently fluid so that the whole content of the barrel could be poured out through the bung-hole.

Q. 53. In practicing the process which you have de-

scribed, at Basin, is the oleic acid used in the solid form?

A. It is not.

Q. 54. What do you do to it?

A. It is heated and brought into a fluid condition before being used.

Q. 55. Do you consider it necessary to reduce the oleic acid to a fluid condition in order to make use of it in the flotation process?

A. I do.

Q. 56. Do you know of any oil flotation process that is applicable to all sulfid ores, or is it your observation that different ores require different treatment, or that some defy any treatment by this process?

A. I do not know of any process of oil concentration which is universally applicable to all sulfid ores. I have attempted to work out a successful method of treatment of ores containing very finely-divided chalcocite, copper, sulfid, trying many different types of reagents in different amounts, without being able to get commercially useful results. Many mixed sulfid ores containing sulfids of lead, zinc, iron and copper can be made to yield tailings very free from sulfid, but the resulting concentrate containing the different sulfids mentioned is scarcely, if any, more easily marketable than the crude ore from which it has been concentrated. My own experience is that there are comparatively very few ores which may be completely successfully treated by oil concentration alone.

Q. 57. In your investigations in Mexico, for Minerals

Separation, Limited, did you find ores or tailings amenable to treatment by the methods contemplated by Minerals Separation, Limited?

A. If you will excuse me, I prefer not to answer that question, as my instructions from Minerals Separation were to give out no information with regard to the matters investigated while in their employ.

The Examiner notes that the following documents referred to by the witness in his answer to Q. 4 are marked for identification as follows:

Cable Hoover to Hyde, January 18, 1910.

Letter Minerals Separation to Hyde, March 2, 1910.

And that the following documents referred to by the witness in his answer to Q. 17 are marked for identification as follows:

Letter Minerals Separation to Hyde, November 23, 1910.

Cable Minerals Separation to Hyde, December 8, 1910.

Copy Cable Hyde to Minerals Separation, December 9, 1910.

Copy Memorandum *re* the Managership of Minerals Separation American Syndicate, Limited.

And the following document referred to by the witness in his answer to Q. 18:

Letter Minerals Separation to Hyde, February 1, 1911.

Direct Examination closed.

Deposition of James M. Hyde.

Cross-Examination by Mr. Williams, de bene esse.

Not waiving the objections and notices heretofore stated and given.

X-Q. 58. You have stated that you are the defendant in this suit. Is it a fact that you are paying the expenses of the defense of this suit, or is some one else paying or contributing to the payment of these expenses, and, if so, who is thus contributing or paying these expenses?

BY MR. KREMER: We object to the question last interposed for the reason that it is improper cross-examination, has no bearing upon the issues in this case and seeks to elicit no testimony which can in any way bear upon the issues in the case, and is incompetent for all purposes, for the further reason that the question is directed to the personal affairs of the defendant, and is frivolous in so far as this action is concerned, and cannot, under any view of this case, be considered as directed to the merits of the case, and for the further reason that it is such a question as falls within the rules of this court providing penalties for the asking of same, and, at the time of interposing this objection, we desire to state that if this question is pursued, we shall be compelled to ask the court to invoke the rule above referred to and so made and provided as to prevent the asking of such questions during the taking of testimony under such conditions as this testimony is here taken.

By Mr. Williams: It is submitted that it is relevant and material whether or not the defendant has others in privity with him in the defense of this suit, more especially as the circumstances suggest the fact that the Butte & Superior Copper Company, Limited, is in privity with this defendant. It is further submitted that the complainants are entitled to know whether or not such privity exists, especially as the fact is of paramount importance in the enforcement of any orders that this court may make. No privilege appearing, an answer to the question is insisted upon.

By Mr. Kremer: Realizing that arguments have no place upon the record at this time, but being mindful of the fact that Butte & Superior Copper Company, Limited, is not made a defendant in this action, and of the fact that counsel for complainants is likewise aware of this fact, having drawn the bill of complaint herein, and also realizing that this court can and will find means of enforcing its orders and its rules, we renew our objections and again assert that the matter will be presented to the court in the manner indicated, for under these conditions testimony cannot be sought solely for the purpose of use other than in the pending cause.

A. I am paying the expenses of the defense of this suit with the exclusive right to use in the Butte district the process covered by my U. S. patent 1,022,085, that exclusive right being granted to the Butte & Superior

Copper Company for such sum of money as is necessary to cover the expenses involved in the defense of this suit.

X-Q. 59. By whom have you been employed as consulting engineer?

A. By the Guanajuato Consolidated Mining & Milling Company of Guanajuato, Mexico, and the Oroya Exploration Company, of London and Australia.

X-Q. 60. During what period were you employed by the Guanajuato Consolidated Mining & Milling Company as consulting engineer?

A. I have not the exact date at hand, but I believe that it was during the year 1905.

X-Q. 61. During what period were you employed by the Oroya Exploration Company, as consulting engineer?

A. I did special consulting work for the Oroya Exploration Company in the month of February, 1911.

X-Q. 62. By whom were you employed as a valuer of mines?

A. I went to Mexico in 1905 or 1906 for Bewick, Moreing & Company, of London, England, where I worked with Mr. T. J. Hoover for a short period, in searching for mining ventures, my work consisting largely in sampling and figuring the value of mines. The work which I did in Butte, Montana, for Hayden, Stone & Company was of this nature, and the work done for Minerals Separation, Limited, was also of this nature. I have also done casual work of this type on small properties in California, Nevada and Oregon.

X-Q. 63. By whom and when were you employed as superintendent of mines and mills?

A. In the year 1907 I was for a period superintendent of the mill of the Canyon Milling Company, at Manhattan, Nevada, and also of the mill and mines owned or controlled by the Manhattan Ore Reduction and Refining Company, of Manhattan, Nevada.

X-Q. 64. When did you graduate from the department of geology and mining of the Leland Stanford, Jr., University?

A. In 1901.

X-Q. 65. What degree did you receive?

A. The degree of Bachelor of Arts.

X-Q. 66. When were you professor of mining and metallurgy in the University of Oregon?

A. During the academic years 1902 and 1903, 1903 and 1904, 1904 and 1905.

X-Q. 67. What members of the board of directors of Minerals Separation, Limited, endeavored to persuade you to give them a contract for two years of your time, as referred to by you in your answer to Q. 4?

A. Dr. Gregory, Mr. Francis Gibbs and Mr. John Ballott, chairman of the company, Mr. Ballot being so insistent upon the matter that Mr. Gibbs and Mr. Gregory finally counseled him, in my presence, to push the matter no further.

X-Q. 68. You have produced a letter dated March 2, 1910, and addressed to you, from Minerals Separation, Limited; I now show you a letter dated March 3,

1910, and ask you if this is your letter in reply and acceptance of the employment tendered in the letter produced by you?

A. It is.

The Examiner notes that the letter identified by the witness is marked for identification "Hyde Acceptance, March 3, 1910."

X-Q. 69. I note that this letter refers to cable messages between Mr. T. J. Hoover and yourself, dated January 18, 20, 21 and 24, 1910. You have produced a cable message dated January 18, 1910. I now produce a cable message dated January 20, 1910, with a translation written thereon. Are these two documents the first two of the cable messages referred to in that letter?

A. I cannot absolutely identify this from memory. I have no copy of it in my files which are at hand.

X-Q. 70. Have you any reason to doubt that this is not the message which you sent on January 20, 1910, to Mr. T. J. Hoover?

A. I have not.

X-Q. 71. The next cable message referred to is dated January 21, 1910, and was sent to you. My copy of this message says "£100 will be telegraphed if you can leave during next week." Can you produce this cable message?

A. I do not think I can from the files which are at hand. These messages came to me while I was in San Diego, California, and in the hurry of getting away I believe they were left with papers which were stored there.

Deposition of James M. Hyde.

The Examiner notes that no objection is made to the marking for identification of the cable message produced in answer to X-Q. 69 as "Cable Hyde to Hoover, January 20, 1910," and the marking of the copy of the message referred to in X-Q. 71 as "Copy Cable Hoover to Hyde, January 21, 1910," and the marking of a cable message now produced dated January 24, 1910, as "Cable Hyde to Hoover, January 24, 1910," and to the use of these documents in evidence with the same force and effect as if the witness had identified them, it being understood that the translation of the code words therein contained is in substance correct.

Adjourned until Friday, April 26, 1912, at 10 A. M., same place.

Met pursuant to adjournment.

Cross-examination of James M. Hyde continued:

X-Q. 72. From the letter marked for identification "Letter Minerals Separation to Hyde, November 23, 1910," which you have produced, I quote the following:

"After attending to the above matters, please proceed to Butte, Montana, and there go into the Zinc situation with the same minute care which has attended your investigations of the various fields in Mexico. Also test the tailings and various products you can secure from the copper mines and mills, say as little about your connection as is consistent with getting information."

Deposition of James M. Hyde.

Was not the Butte & Superior Copper Company an important element of the zinc situation in Butte, Montana?

A. To the best of my knowledge and memory, the name of the Butte & Superior Copper Company had never been mentioned to me by anyone connected with Minerals Separation, Limited. I do not doubt that they knew of that property and of Senator Clark's adjoining property, from which zinc concentrates were being shipped to Beer, Sondheimer & Company for treatment, through Beer, Sondheimer & Company who were associated with them in the Mexican syndicate, in whose behalf I had been retained to give my services for one year exclusively in searching for ventures in Mexico. These two properties are an important feature of the zinc situation at Butte.

X-Q. 73. As a matter of fact, the mines at Butte are principally copper, and the two properties that you have mentioned are about the only zinc mines. This is true, is it not?

A. The properties which I have mentioned are the most important producers of zinc in the Butte district, in which, until the last year or two, no attempt had been made on a large scale to make use of the zinc ores which occur in great quantity in a number of properties. In the Butte & Superior mine and Senator Clark's Elm Orlu mine, which is the mine I have referred to in my answer to the previous question, the zinc ore is of greater purity than in other parts of the district, but in one section of the district I understand that practically all of the mines contain considerable zinc, and I am informed

by the officers of the Amalgamated Copper Company that many of the large copper producers contain notable amounts of zinc-bearing ore of such grade that they should ultimately be large contributors to the zinc output of the camp. It is my private belief that Butte will eventually become as important a factor in the zinc industry of the country as it is now in the copper industry.

X-Q. 74. Please compare the documents which you produced as a copy of your "Memorandum re the Managership of Minerals Separation American Syndicate, Limited," the two documents which have been sent to me from the files of the complainants, marked by me A and B, and advise me which of these documents represents your memorandum as submitted to the directors of the complainant company?

A. After comparing the papers which you hand me, I note that there are differences between them and that the copy which you present marked A is not signed, as I believe was the final copy, or rather original, which I presented to Minerals Separation, and that the copy which I produced bears amendations which it is my memory were a part of my final communication upon this subject. I therefore conclude that the copy which I have produced is a true copy of my communication to the company upon this subject.

The Examiner notes that the documents which were produced in propounding the last question are marked for identification "A" and "B," respectively.

X-Q. 75. Upon comparing the document marked "B"

Deposition of James M. Hyde.

with the copy of the memorandum produced by you, they appear to be, in their typewritten parts, identical, but the document marked "B" contains several blue-pencil deletions and a few black-pencil amendments. What is your recollection as to these deletions and amendments, and by whom were they made?

A. My memory is that this communication was discussed with Mr. Francis Gibbs, Jr., of the Board of Directors, and that certain changes from the original draft were suggested by him as likely to make the communication more acceptable to the financial associates of Minerals Separation, Limited, in the American Syndicate. I recognize that the pencil handwriting on these sheets is not my own and presume that the pencil handwriting was placed there by Mr. Gibbs.

X-Q. 76. I now show you a letter apparently signed by you, dated January 17, 1911, and ask you if you identify this as the letter delivered by you to Minerals Separation American Syndicate, Limited, withdrawing your memorandum "re the Managership," and expressing your unwillingness to contract with the company for another year?

A. As I have in my file an exact copy of this letter and as the letter produced by you is apparently signed by my handwriting, I take it to be the original letter which I presented to the company.

The Examiner notes that the letter referred to is marked for identification "Letter Hyde to Minerals Separation American Syndicate, January 17, 1911."

Deposition of James M. Hyde.

X-Q. 77. In your answer to Q. 4, in paragraph beginning "I stated to them," and ending "mutually agreed upon," you state the reasons which led you to consider it undesirable to make a contract for more than one year's time. To whom and in whose presence were these statements made?

A. It is my memory that those reasons were given to one or more of the following persons Mr. John Ballot, Dr. Gregory and Mr. Francis Gibbs, Jr., directors of Minerals Separation, Limited. I think I also stated them to Theodore J. Hoover, who was at that time the company's Consulting Engineer, and, if I am not mistaken, General Manager.

X-Q. 78. For how long a period after March 3, 1910, did you remain in England?

A. To the best of my recollection until the 8th or 9th of April of the same year.

X-Q. 79. And then where did you go?

A. I then proceeded to New York.

X-Q. 80. And during what period did you collaborate with Mr. T. J. Hoover in the production of the slide machine?

A. During the period in which I was in London. My departure from London was delayed by waiting for the slide machine to be built according to our first design, to be tested and then slightly modified.

X-Q. 81. What equipment for testing ores did you have during your work in Mexico?

A. My equipment for testing ores while in Mexico consisted of one or more slide machines sent to me from

Deposition of James M. Hyde.

London and such dishes, stoves, etc., as I purchased in places where I worked, together with a small balance and miscellaneous small supplies purchased in El Paso, Texas, and such small motors as I was able to make use of in places where I worked.

X-Q. 82. Did you make any bottle tests while in Mexico, using oil, acid and water, and finely-ground ore, and nothing else?

A. It is my recollection that I did, although I have never, while with Minerals Separation, made very many tests of that type, as I had the means at hand for doing quantitative work.

X-Q. 83. A bottle test such as I have described is rather crude and inconclusive, is it not?

A. With proper manipulation, it is practically absolutely conclusive as to whether or not the sulfid contents of an ore can be made to float. In fact, this test was held in so high esteem by Minerals Separation, Limited, that Mr. T. J. Hoover, their chief technical adviser, assured me that it was useless for me to burden myself with heavy test apparatus, because this test would always give such an indication of what could be done with an ore that it was a safe guide as to whether or not an ore tested by it was worthy of further investigation and that it would be a saving of time to rely upon the London test works to make all quantitative tests, but in deference to the wishes of the Board of Directors that I should be able to report as to quantitative results obtained in the field, we considered it worth while to devise and make field use of the slide test machine. I believe

it possible to so manipulate this test as to get a fair idea of the probable percentage of recovery to be obtained with treatment of an ore by froth flotation.

X-Q. 84. Is the test which I have described, in which nothing is added to the finely-ground ore except water, oil and acid, the bottle test which you have said you recognized to be the exact test given by Froment in his British patent 12,778 of 1903?

A. With the exception that this test is carried on in a bottle, whereas the test given by Froment was carried on in a test tube, a difference of no importance, I consider the tests to be absolutely identical in the case of the Butte & Superior ore or any ore carrying soluble carbonates, or any minerals upon which sulfuric acid may react with the formation of gas, as it does in the case of the Butte & Superior ore on the finely-divided zinc sulfid. Further, as Froment states that a gas of any kind may be liberated in the water or in the pulp, I believe that it would be impossible to carry out this test in the presence of a small amount of oil without entraining an amount of air with the oil which would surcharge the water with air, a certain portion of which air would not only be freed but, in a strict sense, absolutely liberated, in the pulp when agitation ceased, and the mass was allowed to come to a quiet condition. As stated by Mr. Nutter in his testimony, the entraining of air commences when the water surface is broken and coincidently with the breaking up and mixing through a wet pulp of oil which may be present. I have repeatedly shaken up water in a bottle or test tube with a drop of oil and have

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always found that the mass becomes milky white from the inclusion of air, which air continues to separate from the water for a considerable period after the agitation has ceased.

X-Q. 85. Now assume a bottle test such as I have described with an ore not carrying soluble carbonates or any mineral on which sulfuric acid will react with the formation of gas, would such a test be the exact test given by Froment in his British patent 12,778 of 1903?

A. I am not able for the moment to call to mind any ore which would be amenable to treatment by a so-called froth flotation process which would not contain constituents which would be reacted upon by sulfuric acid. That zinc sulfid, as the mineral blende, when finely ground is acted upon by sulfuric acid with the formation of hydrogen sulfid, has already been stated. It is my belief that the other sulfids which it is possible to float as a froth are also so reacted upon, and I should consider that if the metalliferous minerals contained in an ore were by such a bottle test made to float as a froth the presence of the froth of which gas is an essential constituent would indicate that gas had been liberated in the mass during or after agitation. I would consider that any test such as you mention which produced a froth containing metalliferous minerals would be such a test as that cited by Froment in the patent referred to.

X-Q. 86. And you had in mind, did you not, in answering the last question, the very highly dilute condition of the sulfuric acid in the bottle tests which produce a satisfactory mineral froth?

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A. The bottle test, as I have seen it used by Minerals Separation, always included the use of a few drops of sulfuric acid, which is exactly what Froment calls for, and was in that point always identical with his specifications, and, further, the solvent effect of the sulfuric acid was always made more pronounced than he specifically calls for by using a warm solution for the test. It is a well-established and commonly-known fact that warm solutions of acid are more active as solvents than are cold ones. As no definite specification was made in your previous question as to the amount of sulfuric acid used or the quantity of water or ore to which it was added, I assume that you were referring to the test as ordinarily made by the technical assistants of Minerals Separation, Limited.

X-Q. 87. And by yourself, I take it, when you were working for them?

A. In such tests as I made while in the employ of Minerals Separation, Limited, I used such an amount of sulfuric acid as was required to give a result with the ore being tested, never measuring the amount with great care, but adding sulfuric acid until agitation either gave a froth, or until I was convinced that the ore being treated would not yield a froth.

X-Q. 88. In the flotation separation apparatus used by you at Basin, Montana, what percentage of sulfuric acid was employed in the pulp solution which was fed to the first agitating box.

A. I have no absolutely definite information upon this point.

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X-Q. 89. What was the consumption of sulfuric acid per ton of ore treated, on the average?

A. I never had any absolutely reliable information as to the exact tonnage of ore which was being treated, and can therefore not give absolutely reliable information with regard to the average consumption of sulfuric acid per ton of ore treated.

X-Q. 90. Is it not a fact that the cost of the sulfuric acid is an essential element in determining the commercial value of such a process as you used?

A. It is, but the conditions under which the operations were carried out at Basin were such that it was not possible there to determine the actual commercial value of the process as practised.

X-Q. 91. What is your present knowledge as to the cost or consumption of sulfuric acid per ton of ore in this process?

A. From reports prepared by Mr. Smith, who was taking samples while tests were being run with the experimental machine, it was indicated that the consumption of sulfuric acid amounted to from a quarter to a half-pound per ton of ore treated, when it was used in the particular way indicated in my patent and practised at Basin, that is, by being added previous to the thickening of the pulp.

The reason I have referred to the information as not absolutely reliable was because the calculations as to tonnage were based upon the weight of quart samples of the feed pulp which were taken from time to time, as was also the number of gallons per minute flowing

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through the plant. The percentage of solids in the feed was determined by reference to a chart prepared by Smith, giving the percentage of solids in a quart of pulp for different weights of the quart of pulp. The chart and method have since been demonstrated to be so unreliable that no common factor even can be used for corrections of its errors and the reports based upon such observations are so inaccurate as to be unworthy of consideration as evidence.

X-Q. 92. What treatment was the ore subjected to prior to the entrance of the pulp into the pulp thickener, as you have designated it?

A. The crude ore coming from the mill was elevated to ore bins and fed through a jaw-crusher of the Blake type. From this it passed to a revolving trommel or screen, water being added to it at this point. Following the usual mill procedure, it passed through various stages of crushing and screening, rolls being used for the finer stages of the crushing, until it was all sufficiently fine to pass through a screen having apertures of seven millimeters diameter. It was then roughly classified, the slimes being sent to Callow cones to be thickened, the coarser portion of the ore passing to Foust jigs in which the coarser parts of the free mineral ~~was~~ were removed from the poorer portion of the ore and recovered as coarse concentrate, two of these jigs being used in sequence, the rougher making rough concentrates and the cleaner making clean concentrates. The tailings from both of these jigs were further crushed by rolls until the whole product was passed through a screen hav-

ing an aperture of 2½ millimeters. This material was then classified roughly, the fine slimes being sent to the Callow cones to be thickened, the sands being sent to other Foust jigs, which removed a certain amount of the free mineral as a sand concentrate. The tailings from these jigs being further crushed by a Chilean mill, after which by classification, they were divided into portions, the coarsest of which went to Hartz jigs, which made concentrates to be saved and tailings to be thrown to waste; a finer portion going to Wilfley tables which made shipping concentrates and tailings, the coarser portion of which went to waste, the finer portion going to vanners for further treatment; the slimes going to the Callow cones for thickening. The vanners made concentrates, of such low grade that it was found desirable to retreat them in the flotation department, and tailings which were thrown to waste. The thickened product from the Callow cones was the material which was led to the pulp-thickeners previously referred to and, after acid-treatment and thickening, became the feed for the flotation machine.

X-Q. 93. When the pulp entered the pulp-thickeners in which you suggested the use of an acid treatment, about what was its condition as to thickness?

A. It was pretty dilute.

X-Q. 94. And about what proportion of clear water was overflowed in these pulp-thickeners?

A. The water overflowing was in no place absolutely clear. The pulp-thickeners were too short to give the maximum efficiency. I have no reliable data at hand which I can quote in answer to this question.

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X-Q. 95. Please answer, then, upon your general knowledge and observation.

A. It is my recollection that it was reported to me that the pulp flowing to these tanks contained 20 to 25 parts of water to 1 part of ore, by weight, and that the overflow going to waste contained from 60 to 100 parts of water to 1 part of ore, while the feed going to the flotation machine fluctuated between some such limits as from 3½ to 11 parts of water to 1 part of ore. Any more definite answer that I would give to your question would have to be based upon computations based upon these figures, and would necessarily be conjectural and inaccurate.

X-Q. 96. I take it that you have no doubt that the pulp which was fed to your flotation plant and entered the first agitation box thereof contained less than 1 per cent. of sulfuric acid?

A. It is probable that it did not contain more than 1 per cent.

X-Q. 97. It seems to me a reasonable conclusion that it contained much less than one per cent. of sulfuric acid. Do you agree with me as to this?

A. It is reasonable to so assume, but, as the amount of acid used in proportion to the ore treated was not accurately determined and was sufficient to cause such a reaction upon the ore as to make the odor of hydrogen sulfid apparent both at the pulp-thickeners and in the flotation plant, I would not feel justified in committing myself to any definite conclusion as to what

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amount was used in proportion to the amount of water or ore.

X-Q. 98. What became of the sulfuric acid in the overflow from the thickener in which sulfuric acid was added to the pulp?

A. It passed off with the overflow water which flowed to waste.

X-Q. 99. Referring now to the typical test first described by you in your answer to Q. 45, at what temperature was this test conducted?

A. I have no record of what temperature at which this test was made.

X-Q. 100. What is your best recollection?

A. My best recollection is that while making the series of tests of which this is one, it was my custom to put into my machine the hottest water which was available, which was frequently at almost boiling heat, but which would be cooled by contact with the machine to a temperature of approximately 60-65° Centigrade. As this practice was not always followed, and I was performing many tests, I cannot say that I have any definite memory as to the conditions of temperature under which this test was made.

X-Q. 101. You say that you used a sample of ore from the mill. Please more definitely describe the sample which you used.

A. My note-book bears the following record as a title to this test: "Slime Table Heads plus alum, four days." My recollection is that this is material which was collected over a period of four days time as

a sample of the material being treated by the Wilfley tables which were treating what was called a fine feed. This was the material which was later used as the feed for the flotation test machine. The reference "plus alum" refers to the fact that a very small amount of alum had been added to the pulp, as collected, in order to settle the slimes so that clear water could be turned off, and it would not be necessary to dry down the whole sample which filled several half-barrels. My tests have indicated to me that the use of alum in this way does not disadvantageously affect the results to be subsequently attained in treating ore by a flotation process.

Adjourned until Monday, April 29, 1912, at 10 A. M., same place.

Met pursuant to adjournment.

X-Q. 102. Continuing my reference to the physical test first described by you in your answer to Q. 45, please supplement your description, more particularly as to the speed of rotation of the agitator blades, the diameter thereof, and the period of time and the number of times the agitation was carried on, and any other particulars that may be necessary in order to reproduce this test.

A. I have no description in my notes of the exact dimensions of the test machine used, but, from memory, would state that the approximate width of the slide machine was probably 4 or 5 inches, the probable diameter of the impeller, 3 or 3½ inches. The im-

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peller was a simple, cross-like metal agitator having two cross arms attached to a hub. These arms had a height of approximately one-half inch and a thickness of not over probably an eighth of an inch. This impeller was attached to a vertical shaft introduced into the agitating chamber through a stuffing-box or gland in the bottom of the agitating box, and was driven by an electric motor, power being transferred to it by a small belt. I have absolutely no record as to the speed, it never having been determined, and having varied through a considerable range at different times, because the motor was upon a moving block or board, and the belt frequently ran so loose that the full speed was not transmitted to the impeller. The agitation was brisk.

In most of the tests of the series from which this one is taken, the pulp was agitated for from twenty to forty seconds, when it was allowed to come to rest, and after the gangue material had settled sufficiently to show clear water through the window in the side of the machine, the concentrate floating in the upper portion of the machine was removed by sliding the upper half of the machine forward and emptying its contents into a pan. The upper portion of the machine was then pushed back into position, clamped into place, and sufficient water added so that about a quarter of an inch of water was visible through the window in the upper half of the machine. The operation of agitation and removing of froths was repeatedly performed so long as a material amount of concentrate

was produced by each operation. The time of agitation was as before. Usually but two portions of concentrate were removed, a third agitation rarely giving enough added concentrate to be of consequence.

I believe that the manipulation just described was that by which the results cited in the test referred to were obtained. There is no record in my note-book describing this test more fully than to give a description of the material treated, the weight and assay value of the ore used, and the concentrates and tailings resulting from the test, the numbers which were attached to these when sent to the assayer, and the percentage of recovery indicated.

From memory I would state that the material treated was very fine,—would all pass through a 60-mesh screen, most of it~~,~~ being fine enough to pass through a 100-mesh screen.

X-Q. 103. You have not, in your description, stated the amount of water used originally in this experiment. What was this amount?

A. Approximately 1700 cc.

X-Q. 104. Now referring to the second test described by you, in which you used 9 cc. of oleic acid, please supplement your description by such particulars as would enable us to reproduce the test.

A. The manipulation in this case was practically identical with that described in my preceding answer. The note-book contains this additional data: "3 froths, 1 film obtained, Result excellent." The oleic acid used in this case, I remember to have been from a sample

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of purer red oil which Charles T. Perry & Company, of Helena, Montana, had submitted to me in response to a request to submit sample of oleic acid or red oil with the lowest melting-point which they could produce in commercial quantities.

The red oil used in the test just previously described was from a sample of impure oleic acid, which they have regularly produced and marketed under the name of "red oil." This was the material used as oil in the test carried on with the experimental machine.

X-Q. 105. Will you send me a specimen of each of these varieties of oleic acid used by you in these experiments?

A. I will arrange to have it sent to you from Butte.

X-Q. 106. And will you also send me a specimen of the ore used in these experiments in the condition in which it was used therein?

A. I will arrange to have this duplicated, as nearly as possible, for you.

X-Q. 107. Now as to the test wherein you used 0.3 cc. of cotton-seed oil, please supplement your description by such particulars as will enable us to reproduce this test?

A. The series of tests with cotton-seed oil were all carried out substantially as has been described in my answer to X-Q. 102. I have no record in my notebook, and cannot state from memory definitely, as to the period for which the pulp was agitated in these tests, but my memory is that it was from twenty seconds to a minute. It may have been even more than a minute.

Deposition of James M. Hyde.

The amount of water used was approximately 1700 cc., the water was warm, but I have no record of its temperature. My note-book bears notes of these tests as follows, with a test in which 5 cc. of cotton-seed oil was used: "3 good froths, concentrates not cleaned"; with a test in which 10 cc. of oil was used, "3 froths, concentrates cleaned"; with a test in which 20 cc. of oil was used, "4 froths, last very small, concentrates cleaned."

The phrase "concentrates cleaned" refers to the fact that the concentrates recovered in the several successive treatments of the ore were united and returned to the test machine after the tailings had been discharged from it. To these was added enough water to make the total amount present approximately 1700 cc., and they were reagitated substantially as before, and the floating concentrates were removed. This operation was repeated one or more times. The tailings or middlings resulting from this operation were added to the tailings produced in the first treatment of the ore. It is possible that a drop or two of acid and oil were added during this retreatment of the concentrates, but I do not remember that this was done.

X-Q. 108. Did you use the same slide machine in your cotton-seed oil test as in the oleic acid test?

A. The machine used was not the same machine, but was its duplicate, made from the same pattern in the same foundry.

X-Q. 109. If required, will you produce one or both of these slide test machines, for the inspection of our experts and use by them, if necessary?

Deposition of James M. Hyde.

By Mr. Williams: Counsel for defendant having stated that one of these slide machines, used by the defendant in his tests, will be introduced in evidence during the taking of this testimony, the question is withdrawn.

By Mr. Kremer: Counsel for complainant having submitted the statement that upon the presentation of the testimony of their expert, the slide machine used by their expert in the tests with reference to which their said expert may testify, will be introduced in evidence, the defendant now states that before the conclusion of their expert testimony one of the slide machines, being a duplicate of the other, will be introduced in evidence, for the inspection of the court.

X-Q. 110. Referring now to your patent No. 1,022,085, I quote the following, page 1, lines 75-81:

"By following this method, I have been able to get highly satisfactory results when using as little as one-quarter of a pound of crude acid per ton of ore treated, whereas in previously-used methods, several pounds have been found necessary."

Again on page 3, in giving an example of use, the specification says, lines 101-107:

"To this pulp while in transit to the thickeners, was added an amount of commercial sulfuric acid equivalent to from one-quarter to one-half pound per ton of ore treated. At times a decided

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odor of hydrogen sulfid could be noticed around the pulp-thickeners."

In your answer to X-Q. 91, you mention a determination of a consumption of sulfuric acid from a quarter to a half pound per ton of ore treated, and you say that this determination was so inaccurate as to be unworthy of consideration as evidence.

Are the quoted statements in your patent founded upon these unreliable and inaccurate observations?

A. At the time the application for the patent was drawn, and, in fact, until within the last thirty to sixty days, the data referred to in my answer to X-Q. 91 was considered to be reliable, within the limits of error incidental to mill-sampling. The figures given in the patent were based upon the reports referred to in my answer to X-Q. 91. The amount of sulfuric acid used, while very small, was sufficient to cause chemical action on the metalliferous minerals present, and was therefore a different amount from that specified by the patentees of the patent in suit, who particularly specified that they used an amount of acid "insufficient to cause chemical action on the metalliferous minerals present." The only evidence at hand as to the amount in pounds proportional to the tons of ore treated in the experimental plant, is that referred to in my answer to X-Q. 91.

BY MR. WILLIAMS: The reference by the witness to the patent in suit is objected to as volunteered.

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X-Q. 111. Then, as I understand you, the statements which I have quoted from your patent are inaccurate, unworthy of consideration as evidence, and, in fact, untrue?

A. The statements referred to are undoubtedly approximately true, but cannot be said to be scientifically accurate, and were therefore, in my answer to X-Q. 91, not vouched for as acceptable as evidence, which I understand must be, in such matters, scientifically accurate.

X-Q. In describing the second oleic acid test referred to in your answer to Q. 45, and the third and fourth cotton-seed oil tests referred to in that answer, you give the percentage of oil to metalliferous mineral contained in the ore. What was the basis of that computation?

A. The basis of that computation was the blende contained in the ore, the amount of which can be arrived at by multiplying the assay of zinc by the factor 1.49. The amounts of other sulfids occurring in the ore were so insignificant that they were not taken into account.

X-Q. 113. What was the cost of the impure oleic acid used at Basin in your flotation plant?

A. This was purchased by the business management of the Butte & Superior Copper Company, and I have no definite data at hand as to its cost.

X-Q. 114. I take it, however, that you have made calculations in which this element of cost has been a factor. If so, what have you calculated it as?

A. When I first learned that Charles T. Perry & Company were producers of impure oleic acid, I applied to them for information as to the price of the same. In one of my note-books I have a note under date of April 19, 1911, that that firm produced oleic acid which "sells in barrels at Helena, Montana, for from 4½ to 6½ cents per pound. The present price is 6⅛ cents, freight to Butte, probably ¼ cent." My memory is that in my calculations, I have used 6½ cents per pound.

X-Q. 115. Now as to the cost of the sulfuric acid used. How have you computed that?

A. I have assumed, from quotations obtained from an acid company in Denver, Colorado, that 93½ per cent. acid would cost approximately 1½ cents per pound, when delivered in tank cars, and 3 cents per pound when delivered in drums.

X-Q. 116. I note that your witness, Jesse C. Gibson, testified that he had charge of the operations of the flotation plant from the latter part of July, 1911, up to about February 7, 1912. I note also that he speaks of the operations having been substantially continuous. On the other hand, you have testified that your so-called experimental machine was used intermittently for probably between one and two months from about the 1st of August, 1911. Please supplement your testimony by such explanation as will clear up this apparent inconsistency.

A. The experimental machine was hastily installed in crowded quarters and was run during a period in

P. 1441, L. 3, insert "for repair and the very frequent shut-downs" after "shut-downs"

truly continuous. Its use was altogether abandoned after it had been demonstrated that the process evolved by me at Basin could probably be successfully used.

X-Q. 117. I still do not understand how Mr. Gibson could have charge of the flotation plant, directing its operations, until the middle of February, 1912. Please explain this.

A. After the experimental machine was abandoned, another machine was made use of in the mill.

X-Q. 118. Was this before or after October 9, 1911, when the present suit was commenced?

By Mr. Kremer: Objected to as incompetent, irrelevant and immaterial, and having no bearing upon the issues of this case, the issue in the case being what was done by defendant at the time specified in the bill of complaint, and not subsequent thereto; and for the further reason that no patentable process has been disclosed by the complainant, and consequently there could be no basis for a claim of infringement.

By Mr. Williams: In view of the fact that the question is carefully limited to what took place before the commencement of this suit, under the charge of infringement in paragraph sixth of the bill of complaint, which covers all that was done

same. In one of my

date of April 19, 1911, that that firm produced oleic acid which "sells in barrels at Helena, Montana, for from 4½ to 6½ cents per pound. The present price is 6⅛ cents, freight to Butte, probably ¼ cent." My memory is that in my calculations, I have used 6½ cents per pound.

X-Q. 115. Now as to the cost of the sulfuric acid used. How have you computed that?

A. I have assumed, from quotations obtained from an acid company in Denver, Colorado, that 93½ per cent. acid would cost approximately 1½ cents per pound, when delivered in tank cars, and 3 cents per pound when delivered in drums.

X-Q. 116. I note that your witness, Jesse C. Gibson, testified that he had charge of the operations of the flotation plant from the latter part of July, 1911, up to about February 7, 1912. I note also that he speaks of the operations having been substantially continuous. On the other hand, you have testified that your so-called experimental machine was used intermittently for probably between one and two months from about the 1st of August, 1911. Please supplement your testimony by such explanation as will clear up this apparent inconsistency.

A. The experimental machine was hastily installed in crowded quarters and was run during a period in

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which many changes were being made in the mill. Because of mechanical difficulties requiring shut-downs of the mill, thereby shutting off the supply of feed for the test machine, its work was intermittent rather than truly continuous. Its use was altogether abandoned after it had been demonstrated that the process evolved by me at Basin could probably be successfully used.

X-Q. 117. I still do not understand how Mr. Gibson could have charge of the flotation plant, directing its operations, until the middle of February, 1912. Please explain this.

A. After the experimental machine was abandoned, another machine was made use of in the mill.

X-Q. 118. Was this before or after October 9, 1911, when the present suit was commenced?

By Mr. Kremer: Objected to as incompetent, irrelevant and immaterial, and having no bearing upon the issues of this case, the issue in the case being what was done by defendant at the time specified in the bill of complaint, and not subsequent thereto; and for the further reason that no patentable process has been disclosed by the complainant, and consequently there could be no basis for a claim of infringement.

By Mr. Williams: In view of the fact that the question is carefully limited to what took place before the commencement of this suit, under the charge of infringement in paragraph sixth of the bill of complaint, which covers all that was done

"before the commencement of this suit," it is submitted that the question calls for evidence relevant, possibly competent, and material.

A. It is my memory that the second machine referred to was thrown into service on or about the 13th or 14th of October. I have no definite record at hand and may be mistaken as to this date.

X-Q. 119. I take it, therefore, that this machine was either in course of construction or completed on October 9, 1911, when this suit was commenced?

A. My memory is that it was in course of construction on that date.

X-Q. 120. Is that machine in existence today?

By Mr. Kremer: Objected to for the same reasons in the objections to X-Q. 118.

A. I believe that it is.

X-Q. 121. When your witness Gibson testified, he stated that at one time additional oil or acid was put into the concentrates after they left the rougher and went to the cleaner, but he could not remember whether this was true on August 10, 1911, when Mr. Nutter saw the plant in operation. Will you clear up this uncertainty, if possible?

A. It is impossible for me to do so, as I have no recollection bearing upon the matter.

X-Q. 122. I now show you Hoover patent No. 953,-746, patented April 5, 1910, and call your attention to a deflector shown in the drawings and marked K. Do you understand this drawing, and if so, did you have

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in your experimental machine any part which performed the function of deflecting or guiding upward the material which flowed from the agitation box to the spitzkasten?

By Mr. Kremer: Objected to for the reason that it is incompetent, irrelevant and immaterial, and has no bearing upon the issues of the case, in that, in the pending suit, the question of apparatus is not in issue.

A. Reading through the text of the whole patent, to get an explanation of the part of the cut to which you refer, I find that several of the claims refer to the use of an inclined guide-plate, in one case referring to it as an inclined adjustable guide-plate. The apparatus used by me, which has been referred to as the experimental machine, did not contain any inclined guide-plate. In front of the opening through which the material agitated in the agitating cells passed into the overflow settling box was placed a submerged trough with horizontal bottom and vertical sides; the top of the front side of this was submerged under 3 or 4 inches of water. The function of this submerged trough was to break the flow of the material and prevent a rapid surface current being directed over the discharge lip.

X-Q. 123. I take it that the broken lines shown in "Defendant's Exhibit Sketch of the Experimental Machine" in each instance alongside of the letters V or V', etc., are intended to represent a plan view of the vertical wall of the trough to which you refer?

A. Yes, and the same might well be indicated by the initials C. R. B., current retarding box.

X-Q. 124. You have described an hydraulic elevator used at two places in your experimental machine. In the use of this hydraulic elevator, was there a constant or substantially constant head maintained, and if so, to what extent?

A. The term "hydraulic elevator" is used in the same sense in which it is used in placer mining, and refers to a jet of water being introduced into a pipe in such a way as to force the contents of the pipe to move in the direction of flow of the current of water which is introduced under pressure. It is my recollection that the pressure water was kept flowing constantly in sufficient volume to cause a continual flow of material. The pressure on the pipe from which the water was drawn was presumably constant, as it is my understanding that the pipe was supplied by water from an elevated ditch or flume, which always contained water.

X-Q. 125. About what was the area of the jet opening of this hydraulic elevator?

A. My memory is that the delivery pipe was one-half inch in diameter. I do not remember definitely as to whether the nozzle end of this pipe was drawn to a small aperture or not.

X-Q. 126. When, to your best recollection, did you first see the patent to T. J. Hoover, No. 953,746, which I have shown you, or a copy thereof?

A. To the best of my recollection, the first time I ever saw a copy of the patent which you have shown

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me was during the spring of 1911, when I received a number of patents relating to flotation processes from the U. S. Patent Office.

X-Q. 127. I now show you a copy of patent No. 979,857, to T. J. Hoover, patented December 27, 1910, and ask you when you first saw this patent, or a copy thereof?

> By Mr. Kremer: Objected to as wholly incompetent, irrelevant and immaterial, and in no way bearing upon the issues of this case, it being specifically shown by the patent submitted to the witness that the invention relates to improvements in apparatus for ore concentration, and does not relate to any process, and the issue in this case is that of a process, and does not bear upon apparatus.

A. The answer to this question is the same as the answer to the previous question.

X-Q. 128. You have said that you and T. H. Hoover designed the slide machine. What was your individual contribution to the design of that machine?

A. My recollection is that after having discussed many possible modes of introducing a sheet of metal or hard rubber or something of that sort through a side opening in a vertical agitating box in such a way as to divide the machine into an upper and a lower part after pulp had been agitated in it, so as to allow the top water and floating concentrates to be drawn off through an opening in the side of the machine above

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the inserted horizontal partition, Mr. Hoover suggested that it should be possible to divide a machine into an upper and a lower portion and slide off the upper portion over a proper guide, as was finally done in the machine which we evolved. We discussed the matter together, making several sketches, details of each being contributed by each of us, and finally upon the form which was finally constructed. Such computations as to size as were necessary were made by me.

The machine as originally designed was constructed under my supervision, was tested by me, and was modified under my supervision in a number of minor features, after the first tests were made.

X-Q. 129. By whom was the machine constructed?

A. My memory is that it was constructed by a Mr. Dearden, a model-maker and machinist in London.

X-Q. 130. Did you, after the termination of your employment by Minerals Separation, Limited, or about that time, endeavor to obtain from this same model-maker a duplicate of this machine for your own use?

A. I discussed the matter with him, explaining that I wished the machine for my own personal use, and obtained from him the figure which he would have to charge for it, if he was to make one for me. He asked me if I thought Minerals Separation would have any objection to his furnishing me with the machine, and I told him that I did not know, but that it was possible that they would. The figure that he asked ~~me~~ for one was entirely prohibitive, and I dropped the matter, knowing that whenever I wanted one I could have one

made for me at a cheaper price. As the machine was unpatented and was designed by myself and Mr. Hoover, I could see no impropriety in attempting to get one made, and naturally went to the man who had previously made one for me.

X-Q. 131. It is not quite clear from your testimony whether or not you saw the testing machine in the London plant of Minerals Separation, Limited, in operation. Please answer as to this.

A. In answer to a previous question I have stated that I saw in operation in the London plant a special test machine devised by Mr. Nutter, and which I understood was not successful. I have no definite memory of having seen any other large test machine working in the London plant. I am of the belief that I did not, and am strengthened in this belief by the definite memory that Mr. Howard, who was foreman at the test works, had promised to write out for me a complete statement with directions as to how to proceed to carry on a working test, and that such statement had not been presented to me when I decided that I should not contract with the company for another year, and that at the time when I called in Mr. Williams, the company's secretary, and turned over to him all papers belonging to the company which were in my possession, which was a week or more before I left the company's service, I addressed and forwarded to Mr. Howard a letter stating that as I was not to continue to work with the company I would request him not to forward to me the statement which he had in prepara-

tion. If I had been familiar with the details of the methods used in carrying on large tests in the London works, there would have been no occasion for him to prepare such a statement.

X-Q. 132. Mr. Nutter, in his answer to X-Q. 51, has described the testing plant at the London works. You saw this plant, did you not?

A. It is not my memory that I ever saw the testing plant in London, which consisted of eight mixers. My memory is that the machine which I saw there had six mixers, with five spitzkastens attached, the first mixer only having no spitzkasten attached to it. I have no definite memory as to the details of valves, piping and mixers of the machine seen in London, nor any record containing this information.

X-Q. 133. What is the extent of your actual knowledge as to the tests of the ore of the San Francisco Del Oro mine, which you witnessed in South Wales?

A. My only personal knowledge on the subject is that I observed that a very scanty and thin froth or film of concentrates was on the surface of the spitzkasten and that the tailings showed the presence of a considerable amount of sulfid minerals.

X-Q. 134. How long did you observe this process in operation at this place?

A. My memory is that on two succeeding days I was present in the Emu works in South Wales, where this test was going on, for perhaps half an hour at a time on a number of occasions on each day. As the work was so apparently unsuccessful, I would go out

and walk about and return to see if the operators were meeting with greater success. The appearance described was typical of that witnessed on all the occasions upon which I remember to have been present in the plant. The attendants were constantly making changes, in hopes of achieving better results.

Cross-examination closed.

Re-Direct Examination by Mr. Scott.

R-D. Q. 135. What, if you know, was the material that was being treated in the experimental machine at Basin, at the time Mr. Nutter entered the plant?

A. At that time the machine was running upon the accumulated low-grade concentrates which had been produced upon the vanners. This was one of those numerous occasions which have previously been referred to upon which the main body of the mill was shut down, and the ordinary feed was not available for the experimental machine.

R-D. Q. 136. Have you found that any particular temperature is necessary in the flotation process as you have practised it?

A. I have found that with the only oil which we have used, the Perry product, which comes to us in a solid form, that it is difficult to obtain the best results, when the temperature of the pulp being treated is much below 25° Centigrade. Above 25° Centigrade and at that temperature, it is possible, by the process which I have worked out, to get higher results than, to my knowledge, have ever been obtained elsewhere.

R-D. Q. 137. To what do you attribute the difficulties in operating at a lower temperature than 25° Centigrade?

A. As I have observed that if the oil used is brought into a fluid condition by heat and then dropped upon the surface of mill-water which has not been heated, and which through a great part of the year is very nearly at the freezing point, that it will solidify at once, I am convinced that the reason that it is difficult to obtain the best results below the temperature indicated, is because the oil becomes solidified before it has been finely divided and brought into contact with the sulfid particles, which it is desired to float.

R-D. Q. 138. In your operations with the experimental machine at Basin, did you add powdered ore to water or acidified water as one of the steps of the process?

A. I did not. The ore treated was never in a powdered condition, and the water in which the ore was crushed was not acidified before coming into contact with the ore.

R-D. Q. 139. At how early a date, as near as you remember, did you first know that zinc ores were being commercially worked in the Butte district?

A. It has been well known for years past, that zinc ores or zinc-bearing ores, occurred in the Butte district. I have no definite memory as to when I first knew that an attempt was being made in the Butte district to produce and market zinc ores or concentrates, but I am certain that I knew of it before the first examination of

the Butte & Superior Copper Company's property was made by Mr. Kuehn, as I knew that H. C. Hoover was interested in investigating some zinc business at Butte.

Re-direct examination closed.

Re-Cross Examination by Mr. Williams.

R-X Q. 140. I take it that in your answer to R-D. Q. 138 you have interpreted the word "powdered" as meaning both finely ground and dry. This is true, is it not?

A. That is my understanding of the meaning of the term, and is the definition which I have found given to it in one or more dictionaries consulted.

R-X Q. 141. Do you suggest that the temperature of 25° centigrade which you have given is the critical temperature below which no substantial results are obtainable in the process as carried on by you in Basin, Montana?

A. I have seen a very considerable recovery made at 20 or 21° Centigrade, if I remember correctly, but at that temperature the appearance of the tailings would indicate that the results being obtained were not the best of which the machine and process were capable.

R-X Q. 142. And haven't you found that better results are attainable at 30° Centigrade than at 25° Centigrade?

A. I have seen the whole appearance of the machine and the tailings indicate as good results when the temperature was 25° Centigrade as at any other tempera-

ture. As a matter of safety, the temperature is usually kept a few degrees higher than that.

Re-cross examination closed.

Re-Re Direct Examination by Mr. Scott.

R-D. Q. 143. At the time of the receipt of the letter from Mr. John Ballot, to which you have referred, in which letter reference is made to Butte, Montana, were you aware of the existence of zinc-sulfid ores at that place, and of the fact that they were being worked?

A. I was.

Deposition closed.

JAMES M. HYDE.

Adjourned until Wednesday, May 1, 1912, at 10 A. M., same place.

Met pursuant to adjournment. Present, counsel as before.

EUGENE A. BYRNES, a witness produced in behalf of defendant, having been duly cautioned and sworn, testifies as follows:

Direct Examination by Mr. Scott.

Q. 1. Please state your name, age, residence and occupation.

A. Eugene A. Byrnes; 50 years; residence, Washington, D. C.; occupation, metallurgical and chemical engineer.

Q. 2. Please state your education and experience in your profession.

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A. I am a graduate of the University of Michigan and Columbian University, having received therefrom the degrees of Bachelor of Arts, Masters of Laws, and Doctor of Philosophy. After graduating from the University of Michigan I taught physics for a short time. I then entered the examining corps of the United States Patent Office and remained there some seventeen years, having been for ten years principal Examiner of the Division of Metallurgy and Electrochemistry, also having charge of the laboratory. Resigning in November, 1901, I engaged in private practice, and am now a member of the firm of Byrnes, Townsend & Brickenstein, with offices at 918 F street, N. W., Washington, D. C. I am a member of various scientific bodies, including the American Chemical Society, the American Electrochemical Society and the Society of Chemical Industry. As Principal Examiner in the Patent Office, it was my duty to determine the novelty and patentability of inventions relating to the treatment of ores and the recovery of metals. I had to do with a great many applications involving the recovery of floating minerals and the recovery of minerals by flotation, including the well known Potter and Delprat methods of flotation, involving the use of a chemically-generated gas. In my own practice, I have also had much to do with the separation of minerals and their recovery by flotation, including improvements on the Potter and Delprat methods and methods involving the separation of sulfids by aeration, such as the Macquisten method, which I assisted in operating and practically demonstrating. I

have visited many of the principal mining sections in the West, and am familiar with the apparatus used in mining and metallurgy. I have frequently testified in patent suits relating to metallurgical subjects, both for individuals, corporations and the U. S. Government, including the recovery of zinc. I maintain a chemical laboratory in the City of Washington, and am principally occupied in investigating the novelty of and giving opinions and testimony relative to chemical inventions and patents therefor. I am an associate editor of the Journal "Metallurgical and Chemical Engineering."

Q. 3. The bill of complaint in this suit charges infringeemnt of United States patent No. 835,120, granted to H. L. Sulman, H. F. Kirkpatrick-Picard & J. Ballot, Nov. 6, 1906. Are you familiar with the contents of this patent and the art to which it relates?

A. Yes

Q. 4. Will you explain your understanding of the patent referred to, making reference in your answer, if necessary, to such matters connected with the prior art as you may desire?

A. This patent relates to the concentration of ores, and to the recovery or separation therefrom of the portion containing the valuable constituent, whether metal or graphite, leaving the gangue or portion containing rock and of no value.

The alleged improvement is one in that old class of methods employing an oil, fatty acid or the like to coat the valuable constituents of the ore, which may be called "mineral," for short, leaving the non-valuable constitu-

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ents, gangue or tailings uncoated, although they become wetted with water.

The three patentees, alleged joint inventors, in the beginning of the description of the patent, refer to the prior U. S. patents Nos. 777,273 and 777,274, granted to A. E. Cattermole, as patents describing general processes of separating metalliferous matters from ore by the use of oil or oleic acid, a fatty acid, calling attention to the fact that this prior inventor used an amount of oil varying from 4 to 6 per cent. of the weight of metalliferous matter present. They then announce the discovery constituting the novel feature, improvement or principle upon which their patent is based, in the following language:

> "We have found that if the proportion of oily substance be considerably reduced—say to a fraction of one per cent. on the ore—granulation ceases to take place, and after vigorous agitation there is a tendency for a part of the oil-coated metalliferous matter to rise to the surface of the pulp in the form of a froth or scum."

They next announce a number of factors or conditions which assist this small amount of oil in coating the metalliferous matter and forming a froth, to-wit:

(1) A slight acidification of the water in which the oiling is effected, that is, the water in which the finely-divided metalliferous matter is in suspension as a pulp, as by the addition of up to one per cent. of sulfuric acid, or other mineral acid or acid salt. This acidification is said to increase the selective

action or preferential affinity of the oily substance for the metalliferous matter, and to prevent it from coating the gangue. The patentees call attention to the fact that the addition of acid is not intended to generate a gas to float the mineral, and state that: "the proportion of acid used is insufficient to cause chemical action on the metalliferous minerals present."

(2) Warming of the pulp, or mixture of water and suspended ore, to which the oily substance has been added, is stated to increase the tendency for the oil to disseminate through the pulp, and the rapidity with which the metalliferous matter becomes coated with oil.

(3) Fine pulverization of the ore is said to assist the formation of froth, and "slime material," that is, the mineral in impalpable small particles floating in the pulp, is said to most readily generate scum, larger particles being floated with more difficulty.

(4) The amount of mineral recovered by flotation of the froth is said to vary with different ores; and

(5) The recovery also varies with different oily substances, necessitating a preliminary test to determine which is most suitable for the particular ore.

The patent then proceeds with a detailed description of the treatment of a particular ore, containing ferruginous blende, zinc sulfid carrying iron; galena, lead sul-

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fid; and gangue consisting of quartz, rhodonite and garnet, silica or silicates containing no metalliferous values. The sequence of operations is as follows:

The ore is finely powdered.

The powdered ore is mixed with water containing up to 1 per cent. of a mineral acid or acid salt, specifically sulfuric acid or ferric sulfate.

A very small proportion of oleic acid, say from 0.02 to 0.5 per cent. on the weight of the ore, is added.

The mixture of powdered ore, water, mineral acid or acid salt, and oleic acid is warmed, say to 30° to 40° Centigrade.

The warmed mixture is briskly agitated in a mixer or the like, for example the cone mixer shown in the specified prior patents to Cattermole, for a period of from two and one-half to ten minutes, until the oleic acid has been brought into efficient contact with all the mineral particles, that is, until they have become coated with this oily agent.

Agitation is discontinued, whereupon a large proportion of the mineral present is said to rise to the surface in the form of a froth or scum, consisting of air-bubbles, introduced into the mass by agitation, adhering to the oiled mineral particles only, the unoiled gangue particles, without adhering air-bubbles, not floating.

The froth is now removed "by spitzkast, upcast, skimming, draining, or otherwise," and may be treated with alkali to remove the oleic acid. If the ore has been crushed to 90 mesh to the inch, from 70 to 80 per cent. of the metalliferous matter in the ore is said to be recovered in this first froth.

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To recover the metalliferous matter remaining in the tailings, especially including the larger particles, various flotation methods may be used, for example:

> The pulp freed from the froth and containing the gangue and non-floated mineral may be aerated by distributing it as a thin layer on a shaking table, air jets being also blown upon it, and the aerated mineral may be floated off and separated from the gangue, which sinks. Reference is here made to a specific process of this character which is described in another United States patent granted to the same inventors, No. 879,985.
>
> An alternative method for the treatment of the tailings consists in placing the pulp containing the tailings and mineral unrecovered in the first froth in a closed vessel and compressing air or gas therein, thereby causing an excess of air to be dissolved in the pulp; and then releasing the pressure and allowing the dissolved air or gas to be evolved in bubbles throughout the mass, these bubbles attaching themselves to the (oiled) metalliferous matter and raising it to the surface as a second froth. This method is referred to as the subject-matter of another application, which has matured into patent 835,479, to the same inventors.

The drawings of the patent illustrate apparatus which may be employed. The agitator for effecting the preliminary oiling of the mineral is illustrated in Figure 1, being a cone agitator of the kind previously employed

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by Cattermole, and shown in his patent 777,273, consisting of a vertical cylindrical vessel in which is centrally journaled a vertical shaft carrying a hollow cone near its lower end. A hopper C and belt-conveyor D carry the crushed ore into the top of the vessel, and a swan-neck pipe H, controlled by a cock G, delivers the froth from the vessel. A pipe F having a cock F′, serves to deliver the oleic acid or other oil, in regulated amounts, into the agitator, corresponding to similar devices shown in the Cattermole patent. The patentees state that several of these agitators may be used, connected in series, as shown in said Cattermole patent, Figure 2 of the drawing illustrates the same agitator, not showing the ore-feeding mechanism.

Figure 1 also illustrates the apparatus used for separating the oiled and aerated metalliferous froth from the water and tailings, consisting of three funnel-shaped chambers, of progressively increasing size, having quadrangular tops arranged in series, these chambers or "boxes" being filled with water and receiving the oiled and agitated pulp delivered from the cone mixer through pipe H, first flowing onto a smooth slightly-inclined plane or flat trough O, which delivers into the smallest chamber or box. The heavier sands and coarser mineral sink in the first box, the medium sands and any residual mineral in the middle box, and the fine sands in the last box. A jet of water may be led into the bottom of each chamber, to assist the separation, as usual in devices of the type termed "spitzkasten." The metalliferous froth floats on over the top

of each chamber and is discharged from the edge of the last chamber into a launder P, delivering to a filter. The water separated from the metalliferous matter is pumped back to the cone agitator, and may pass through a heater in transit. Any mineral, oiled, but not floated, depositing with the gangue in the chambers J^2 or J^3, may be recovered by the method of compressing a gas into the pulp and then releasing the pressure to evolve the gas and aerate and float the oiled mineral of the froth, as heretofore described.

In the modified apparatus shown in Figure 2 of the drawing, the oiled and agitated pulp from the cone mixer is passed through a discharge-conduit a', pipe a^2, pump e and pipe e', into a closed chamber f, wherein it is first subjected to an atmosphere of air or other gas compressed to from 50 to 100 pounds per square inch, for a few minutes, being thence discharged to the froth-separator with three chambers heretofore described. The air or gas dissolved under pressure and evolved upon discharge from the compression-vessel, assisting the aeration produced in the cone agitator, is said to cause all of the oiled mineral to rise to the surface as a single froth, obviating the necessity of retreating the tailings, as with the first apparatus illustrated.

The patentees state that an amount of oleic acid constituting 0.1 per cent. of the ore has been found suitable and economical for effecting the flotation, but that smaller amounts may be used. They also state that the oleic acid may be liberated in the pulp, instead of directly added thereto, by first introducing a dilute soap solu-

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tion and then adding a mineral acid to decompose the soap, referring to the Cattermole patent 777,274 for a description of this procedure. They note that oleic or other fatty acid, coating the mineral, may react with soluble salts of lime, iron, etc., present to form insoluble soap adhering to the mineral and capable of attaching it to bubbles of air and floating it, like the fatty acid itself.

Claims 1, 2, 3, 4, 5, 6, 7, 8, 12 and 13 of the patent in suit are limited to the use of a proportion of an oily liquid having a preferential affinity for metalliferous matter amounting to a fraction of one per cent. on the ore, specifically to the use of oleic acid in amounts from 0.02 to 0.5 per cent., claims 8 and 13 requiring that oleic acid shall be produced in the mass with decomposition of a soap solution.

Claims 9, 10, 11 specify "a small quantity of oil."

Each claim includes the step of agitating the mixture to effect the oiling of the mineral and formation of the froth.

Claims 2, 3, 4, 6, 7, 8, 11 and 12 specify the use of slightly-acidified water, or water containing a fraction of one per cent. of sulfuric acid, claim 11 requiring that the amount shall be insufficient to cause chemical action.

Claims 3, 4, 7, 8, 10, and 13 include the step of warming the mixture.

Claim 13 includes the particular mode of separating the froth by passing the oil and agitated pulp on the surface of a current of water over columns of water, as by the use of the spitzkasten illustrated.

Q. 5. Please compare the subject-matter of patent

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835,120, which you have been discussing, with the prior art as you understand it, stating what, if anything, of novelty you find in that patent.

A. I will first refer to a number of prior U. S. patents, considering them chronologically, to-wit:

No. 345,951, granted July 20, 1886, to Hezekiah Bradford. I quote from this patent as follows:

> "Almost all metallic ores—coal and other substances—when pulverized, contain a greater or less proportion of particles of ore or metal that will, even if pulverized in water, float on the surface of the water, and the finer the substances are pulverized the greater the proportion of floating particles. These floating particles appear to possess some peculiar quality which repels the water from their surfaces, especially when such particles are exposed, even momentarily to atmospheric air, and when such exposure takes place the water is repelled from a sufficient portion of their surfaces to cause such particles to float off on the surface of the waste water from the other particles that sink in the water.
>
> "In concentrating ores they should be pulverized fine enough to liberate the metallic particles and the particles of native metals from their gangue. . . ."
>
> "the floating particles will pass, with a part of the waste water, over the overflow I of tank D into a receptacle, L, in tank M, with a fall sufficient to plunge the floating particles under water. This

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receptacle L should be small enough so that the whole surface of the water therein will be constantly acted upon by the plunging water, in order to thoroughly wet the floating particles, some of which will rise many times to the top of the water before they get wet enough to sink; . . . they will not float again without exposure to atmospheric air. ." "the substances must be conducted to trough R, from which these substances must be raised by an elevator, R′, high enough to be deposited in the trough or incline b^2, which will deliver them upon the belt E, a portion of which is immersed in water in tank D, and the upward motion of this belt will elevate these tailings and floating materials out of the water, so that atmospheric air will come in contact with the tailings. When the belt delivers these substances again to the water, the tailings will immediately sink in the water to the bottom of the tank D, while the particles that repel the water will float and pass off . . ."

This patent describes and utilizes the well known fact that finely-divided minerals, although having a weight or specific gravity much greater than that of water, will nevertheless float on the surface of water, provided they are dry or only slightly wetted, or if wetted, are re-aerated by lifting them out of the water into the atmosphere, whereby they become coated with a film of absorbed air. Such particles float on the water by reason of the well known capillary phenomenon called "surface tension," the upper surface of the water acting

like a thin, elastic membrane, and being slightly depressed by each air-coated particle, not coming in actual contact with it, but depressing the surface of the water beneath it until it displaces an amount of water equal in weight to that of the particle. So, films of dust float on water, although consisting of individual particles of rock much heavier than water. Another familiar illustration of this phenomenon is the fact that a sewing needle, although having a specific weight about eight times that of water, will nevertheless float on water if the surface of the needle be coated with a slight imperceptible film of oil or grease.

No. 348,157, granted August 24, 1886, to Carrie J. Everson. I quote from this patent as follows:

> "The discovery which forms the basis of my invention is that metals and metallic substances in a comminuted state will unite with compounds of fats or oils and acids, and that such compounds will not unite with comminuted quartz or other rocky gangue. The essential feature of the method which constitutes my invention, therefore, consists in commingling with pulverized ore a fat or an oil, either animal, mineral, or vegetable, or a fatty constituent or acid of an animal or vegetable fat or oil, or any constituent of a mineral oil, together with an acid either mineral or vegetable, or a soluble neutral or acid salt, for the purpose of effecting a union of the free metal or metallic portion of the ore with such admixed material, whereby the same maybe retained

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in the subsequent separation of the quartz or other rock therefrom by washing or other suitable means. . . ."

"In putting my invention into practice any fat or oil, and any acid, either mineral or vegetable, or any soluble neutral or acid salt, or any compound of fats and oils with appropriate acids, may probably be successfully employed, at least such is the case with all of these agents with which I have so far experimented. I have used petroleum and one of its several constituents—namely, paraffine-oils—also tallow, (melted,) lard, lard-oil, red-oil, (impure oleic acid,) cotton-seed oil, castor-oil, sperm-oil, and linseed-oil, and some combinations of these with each other. The acids which I have employed are sulphuric, hydrochloric, nitric, phosphoric, acetic, oxalic, tannic, and gallic. I have also used the following salts, to-wit: the sulphates and chlorides of sodium, zinc, and copper, and the double sulphate of potash and alumina. The selection of the appropriate agents will, however, be largely determined in the practical working of my invention by the consideration of economy, which will obviously exclude the greater number of those above enumerated. . . ."

"Take an ore assaying twelve ounces per ton in silver and containing forty-eight per cent. silica, 6.3 per cent. zinc, 1.5 per cent. copper, fifteen per cent. iron and aluminum, 6.5 per cent. lead, 14.18 per cent. sulphur, 7.19 per cent. arsenic. Of this ore take four (4) ounces by weight in pulverulent form, prepare

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a mixture containing sulphuric acid, cotton-seed oil, and water, in all about twelve fluid drams, of which ten drams are of water and about two drams are acid and oil in the proportions of fifteen parts of the oil and two parts of the acid by measure. In making this fluid mixture the acid and oil are first mixed with each other, the acid being added to the oil very gradually, so that the temperature will not rise above 120° Fahrenheit. The stirring in of the acid should be thorough, as it tends at first to gravitate to the bottom. After a few hours, in a summer temperature, the mixture will be ready for use, and, preferably, in such a temperature, should not be prepared long before using, though if it should have stood long enough to solidify it should be gently heated before adding the water thereto. In winter or in air-tight vessels it may be kept for a number of weeks or even longer, and then rendered fit for mixing with water by heating gently when required for use. The water may be advantageously added in installments of about three equal parts, and the mixture stirred for each addition of water until it stiffens. After stirring in the entire quantity of water the compound is added to the ore, the proportions of ore and compound being chosen with a view to producing a stiff mass after the materials have been incorporated, such proportions being therefore variable in different cases with this end in view. The stirring or incorporation of the ore with the liquid should of course be thorough for the purpose of

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bringing the mineral into contact with the oil and acid as completely as possible, and after such incorporation the mass is then in condition for the washing out of the quartz by the action of water which will be applied to the mass in sufficient quantities for this purpose. . . ."

"When petroleum or a constituent thereof is used the oil should desirably be first mixed with the ore, then water added containing a suitable amount of free acid or a soluble neutral or acid salt, the quantity of water being ample for the washing-out operation, which is to follow, and the quantity of acid sufficient to cut the sand away from the otherwise cohering mass. In the case of petroleum or its constituent, paraffine-oil, one or two fluid drams of acid to one gallon of water is sufficient for this purpose. The petroleum which I have used was 30° Baume; and I have found three fluid drams of oil abundant for properly moistening two ounces of heavy ore, or in the ratio of about a barrel of oil to the ton of ore, the amount being, of course, variable with the relative bulkiness of the ore.

"In the use of petroleum, or of a liquid constituent thereof, like paraffine-oil, the condition of the concentrated mass is more liquid than when a vegetable or an animal oil or a fatty constituent thereof is used, and a somewhat different means or method should be employed for removing the sand. In practice, the concentrate, after thorough agitation of the mass and detachment of the sand, will in this case be

preferably removed by means of a constant overflow of water from a washing-out vessel, by which overflow the concentrate will be floated off. Devices and methods now well known in wet separation of ores will be suited to this part of the operation, bearing in mind that the sand and mineral are merely transposed or their relative positions are reversed, because the sand is heavier than the mixture of mineral, oil, and acid. A proper selection of devices for this purpose will be apparent to those skilled in the wet separation of ores. . . ."

"The proportions in which the acids or salts are added to the oils or fats may vary according to the kind of acid or oil employed, and also according to the kind of ore to be treated; and the manipulation of the substances employed may be varied from that above set forth in either formula given. These matters may be determined in individual cases by the operator; and I do not, therefore, restrict myself to any particular proportions of the substances employed, though I have above indicated proportions of certain acids and oils by one of the other of which practical results may be obtained upon almost all varieties of ores.

"It is also not essential to my invention that the acid or salt employed with a vegetable oil be added to the oil before the incorporation of the oil with the ore, as it is entirely practicable, at least in most, and possibly in all, cases, to first mix such oil with the

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ore and thereafter add the acid, as set forth in the use of petroleum."

Adjourned until Thursday, May 2, 1912, at 10 A. M., same place.

May 2, 1912.

Met pursuant to adjournment. Present, counsel as before.

Direct examination of Eugene A. Byrnes continued.

(Answer to Q. 4 continued.)

This patent thus announces several facts of great interest and pertinence, to-wit, that—

(1) Any fat or oil, including red-oil or impure oleic acid, cotton-seed oil, or petroleum and its constituents, has a selective action or preferential affinity for comminuted metals and metallic substances admixed with comminuted quartz or other rocky gangue;

(2) A mineral or vegetable acid, or a soluble neutral or acid salt, such as sulfuric acid or a sulfate, tends to effect a union of the metallic portion of the ore with the admixed fat or oil, and to enable it to be retained thereby during the separation of the gangue, the use of both the fat or oil and the mineral or vegetable acid or salt being specified as the essential feature of the method;

(3) The material used for oiling the mineral

should be sufficiently liquid to enable it to be thoroughly brought in contact with the mineral, and in winter, when it has become solidified, it should be heated to melt and thin it, although in summer temperature such heating may not be necessary. Some of the oils or fats prescribed are solid at ordinary atmospheric temperatures, for example, tallow, which the applicant notes should be used melted. The red-oil, or impure oleic acid, mentioned, ordinarily produced from tallow in separating the stearin and other harder fats used for candle-making, etc., may be either solid or liquid, depending on the season of the year, whether winter or summer. Other oils mentioned, cotton-seed, castor, sperm, linseed, and petroleum, are liquid at ordinary atmospheric temperatures;

(4) The proportions of oil or fat and acid used must vary according to the kind of each employed and according to the kind of ore to be treated, and must be determined in individual cases by the operator;

(5) "The operation of concentration as a whole, or in its practical form as applied to the separation of rocky mineral ores, involves the reduction of the quartz or other rock containing the mineral to a powder."

That is, fine comminution is necessary to liberate the mineral from the gangue, or produce separate particles of each, enabling the mineral to be preferentially coated with the oily material;

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(6) Thorough agitation of the mass or pulp comprising water, the finely divided ore, the oil or fat, and the acid, is necessary, the purpose being to bring the mineral into contact with the oil and acid as completely as possible to enable each particle of mineral to be preferentially oiled. The particular apparatus to be used is not described or illustrated, the statement being made that proper devices can be selected by those skilled in the art;

(7) When the mixture of pulp, oil and acid is sufficiently liquid, as when using a naturally liquid oil like petroleum or paraffin-oil, the mass is first thoroughly agitated and the concentrate will then be separated from the sand or gangue by flotation, "by means of a constant overflow of water from a washing-out vessel, by which overflow the concentrate will be floated off" . . . "because the sand is heavier than the mixture of mineral, oil, and acid." As the patentee states that devices and methods of this character are well known in the wet separation of ores, reference is evidently here made to the use of the common spitzkasten, in which a constant current of water lifts the lighter material which floats off, while the heavier portions gravitate to the bottom against the current.

No. 466,753, granted January 5, 1892, to Edgar A. Hockley. I quote from this patent as follows:

"My invention relates to a novel form and construction of mechanism for treating ores, and is de-

signed to save the float mineral, usually called 'slimes' and sometimes termed 'flour' gold and silver . . . In all classes of ore there is more or less of this light flour or float mineral which is held in suspension by the water, while in some kinds of ore this class of mineral amounts to a very large proportion of the value, which is therefore ordinarily lost or carried to the dump with the so-called 'tailings'."

"The principle of the invention is to aid or increase the natural floating tendency or buoyant condition of the mineral particles, whereby the valuable portion is made to float, while the gangue, which is heavier, settles, thus effecting the separation. . . ."

"air, water, steam, etc., may be forced into tubes 16 and thence into the bottom of the tank for the purpose of agitation, whereby the light mineral is washed or separated from the heavier gangue and an increased upward or buoyant tendency given said mineral, keeping the same upon the surface of the water until discharged into the filtering tank. . . . At the bottom of the discharge end or side of the tank is located the lower trough 19 for carrying away the gangue which settles in the bottom of the tank and the upper trough 20, into which the float mineral passes, which collects in the form of a scum upon the surface of the water."

The patentee, in referring to flour gold and silver as "light," does not mean that the specific gravity of gold

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and silver, or the mineral to be recovered, is less than that of the gangue, but to the fact that it tends to float upon the water by reason of the surface-tension phenomenon heretofore referred to by me, due to the fact that the very small particles of metal or mineral are surrounded by a film which prevents them from being wetted. The patentee proposes to increase the natural floating tendency of the mineral by the use of injected streams of air, etc. Such streams of air would tend to aerate the mineral, or attach more air to its particles, as films or bubbles, enabling it to float as a scum, which moves through a conduit to a filtering-tank.

No. 469,599, granted February 23, 1892, to Albion M. Rouse. I quote from this patent as follows:

> "My invention relates to an improved method and apparatus for removing or separating slime or fines from water carrying ores; . . ."
>
> "As the slime-water passes slowly through the chamber 21 it is acted upon by an innumerable number of air-bubbles escaping from the perforate pipes 26,27, into which the air is forced through pipe 25. The constant upward circulation of air through the slime-water tends to elevate all foreign matter to the surface of the water and to create or form a mass of strong foam having a great carrying energy for matter foreign to water. As the foam accumulates in the chamber 21 it is forced out through the passage 23 to a drier."

No. 676,679, granted June 18, 1901, to Francis E. El-

more. This patent corresponds to British patent 21,-948, dated October 18, 1898, upon which suit was brought in England by The British Ore Concentration Syndicate, Limited, and another against Minerals Separation, Limited, the plaintiff in the present suit. I quote from this U. S. patent as follows:

> "My invention relates to a method of separating metallic constituents of ore from rocky and other impurities, which is distinguished from the usual amalgamation processes in which the ore forms an amalgam with mercury.
>
> "It consists in mixing the crushed ore with water and mixing with the ore and water a substance other than mercury which has the power of causing the metallic portions of the ore only to adhere to it, while the water and rock or other impurities of the ore remain unaffected and may be drawn off. The metallic constituents of the ore are then recovered from the substance in which they are entrapped. I have found that the heavier oils are efficacious for this purpose and particularly that kind of oil known as the 'residuum' of mineral oil after the more volatile elements have been distilled off.
>
> "In carrying out my process I prefer to mix the ore with water—as, for instance, by the wet crushing method in common use—using a sufficient quantity of water to make a freely-flowing mixture, the fineness of the ore depending upon the particular kind of ore treated. I then place the ore and water

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in a suitable vessel, add a quantity of the oil depending upon the particular kind of ore under treatment, and then agitate the mixture without breaking up the oil into small globules. The metallic particles will adhere to the oil and be buoyed up and floated by it, while the other constituents of the ore will remain in the water. The water and attendant impurities are then drawn off, leaving the oil and metallic particles. The metallic particles are easily separated from the oil by mechanical or other means. . . ."

"The lowest layer is drawn away as tailings, which may be again treated with oil by leading them by a pipe *f* to a second drum *g*, where they are again mixed with oil supplied by a pipe *h*, the mixture being discharged into a second subsidence vessel *k*. This may be again repeated until little or none of the metallic constituents remain in the tailings. . . ."

This process is based on the selective action or preferential affinity of oil for mineral rather than gangue, the oiled metallic particles being floated up by the oil, while the tailings subside. The process provides for retreatment of the tailings by the same process of oiling and flotation, to recover any mineral which may not have been floated in the first operation.

No. 689,070, granted December 17, 1901, to Alexander S. Elmore. This patent corresponds to British No. 6519, dated March 28, 1901, which was also involved

in the British suit brought against the present plaintiff. I quote from this U. S. patent as follows

"The selective action of oil has been utilized for separating metallic substances from earthy or rocky constituents of ores. This has generally been done by pulverizing the ore and suspending it in a considerable quantity of water, so as to make a freely-flowing pulp, then mingling with it oil, preferably heavy oil, such as is obtained from petroleum after some of the lighter oils have been distilled from it. When the mixture rests, the oil, with most of the metallic substances entrapped in it, floats at the top and is separated from the rocky or earthy matters, which are run off with the water as tailings. The oil is afterward separated from the metallic substances, usually by centrifugal action. In carrying on this separating process I have discovered that in some cases a slight acidulation of the mixture greatly enhances the selective action of the oil, so that metallic substances, as well as other mineral substances, such as sulfur and plumbago, can be separated from the earthy matters with which they are naturally associated better than when there is no acid present. By this means some metallic substances can be separated from others—such, for instance, as sulfids from oxids. The acidulation may be effected either by adding a little acid to the oil, in which case an acid that will dissolve in or mix readily with the oil, but which is insoluble, or nearly so, in water—as, for instance, olei c acid—is to be

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preferred, or the acid may be added to the aqueous pulp, in which case sulfuric acid may be employed or the acid cuprous liquors obtained in mine working. The quantity of acid added in either case is small, as it often need not exceed one five-hundredth part of the volume of oil or water employed in the operation. The quantity of acid required to produce the best result varies, according to the character of the material treated, and I therefore do not confine myself to any definite proportion. . . ."

"In applying my invention to the separation of metallic and earthy or rocky ingredients of ore I prefer to mix with the powdered ore from five to ten times its weight of water, forming a thin freely-flowing pulp, which I allow to flow into the mixer A through a pipe D. Into this mixer I also admit a thin stream of oil from a pipe E, provided with a regulating valve, and a small quantity of acid from a pipe Q, also provided with a regulating-valve. The oil and acid are mixed with the pulp by the rotating beater C. The oil by its selective action coats or absorbs the metallic particles, sulfids, the tellurids, and the like. If plumbago, elementary sulfur, or other substances of like character are present, the oil attaches itself to or coats such particles, while it does not coat or attach itself to the rocky or earthy particles present."

This patent thus refers to the selective action or preferential affinity of oil for the metallic substances rather

than the earthy or rocky constituents of ores, and to the fact that a slight amount of acid greatly enhances this selective action. Both a mineral acid, sulfuric, and a fatty organic acid, oleic, are mentioned as suitable. The amount of acid to be used is small and is varied to suit the material treated and give the best result. Both the oil and acid are fed to the machine for mixing them with the ore-pulp by a regulating valve, enabling the amount to be suited to the conditions as determined by practical work.

No. 735,071, granted August 4, 1903, to Guillaume D. Delprat. I quote from this patent as follows:

Title: "Extraction of Zinc, Lead, and Silver Sulfids from their Ores."

"This invention relates to the extraction or concentration of sulfid ores to separate them from their gangue.

"The ore is first finely ground or stamped and then immersed or dropped into a bath or solution, hereinafter described. An apparatus for carrying out the process forms the subject-matter of a separate application, filed March 9, 1903, Serial No. 146,-895. This process is readily carried out at ordinary temperatures and depends upon the ore particles being attacked by the acid to form a gas. Each ore particle so attacked will have a bubble or bubbles of gas adhering to it, by means of which it will be floated and can be skimmed or floated off the solution. The particles of the gangue, such as silicates

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and other substances not quickly or readily attacked by acid or dilute acid, fall to the bottom of the body of the solution and are removed from time to time. . . ."

"Under the bottom 4 is a piping 14, forming, with the air-inlet cock 15, a Bunsen burner for gas, so that the solution or liquor may be heated, if desired. The ore fed from the hopper 1 drops into the bath and slides by gravity over the bottom to the sump, the ore particles being raised to the surface of the liquor by the gas-bubbles formed, the action of the acid on these ore particles during their travel along the inclined bottom and ore floated off with the overflow through the trough 13, if desired, skimmed off."

No. 736,381, granted August 18, 1903, to Moritz F. R. Glogner. I quote from this patent as follows:

". . . The mixture containing only fine earthy substances and graphite is mixed with a quantity of water the weight of which is about three or four times as great as that of the graphite mixture. Petroleum is then added in the approximate proportion of one part petroleum to two parts of graphite contained in the mixture. Now the whole is given a strong rotating, rocking, or reciprocating movement within a closed vessel, so that the mixture is thoroughly stirred and intimately mingled. The petroleum is broken up into very fine drops or perles, and every graphite particle when touching them is attracted, while the earthy particles, which were al-

ready saturated with water before the addition of petroleum, remain completely neutral. After the vessel has been allowed to stand the earthy parts sink down, while the petroleum carrying the graphite tends to rise to the surface. After a certain time water is then sprinkled over the surface of the liquid by means of a rose or the like, whereby the fine earthy particles are caused to sink more quickly, and any earthy particles which may be carried upward by the rising petroleum and froth are caused to sink down again.

"The vessel is shaken once, twice, or repeatedly after the graphite has been skimmed, and every time some petroleum is added. The whole of the graphite will then be taken off by the petroleum. . . ."

Apparatus is illustrated and described for carrying out the process, comprising a number of agitators.

"Each agitator A is obliquely suspended on three chains B in such a manner that the wave formed when the vessel is agitated falls back on the higher part of the bottom and a thorough mixing of oil and graphite is obtained, the operation being at the same time facilitated. Each vessel A has a handle C. . . ."

Graphite, to the separation of which this patent is directed, is one of the minerals the recovery of which is contemplated by the patent in suit. The Glogner process relies on the preferential affinity of petroleum for graphite rather than rock and gangue, and directs that

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the mixture of water, ore and petroleum, shall be given a strong agitation, as by rotating, rocking or reciprocating it, thereby causing every graphite particle to be coated with the petroleum. Such strong agitation is well designed not only to intimately distribute the petroleum in very fine drops throughout the pulp, but also to aerate the pulp and cause the oiled mineral to float to the top as a froth. The waves formed by reciprocating the agitating vessels in short shocks would naturally entrain and intermingle with the pulp a large amount of air in the form of bubbles, just as an ocean wave entangles air and forms a floating froth or foam. Agitation by "a strong rotating . . . movement," as suggested, is the type of agitation employed in the patent in suit to form a froth.

No. 745,960, granted December 1, 1903, to Israel F. Good. I quote from this patent as follows:

> "The object of the invention is in a ready, simple, rapid, thoroughly-feasible, and practical manner initially to separate pure graphite from any associated impurities and conserve it and then to effect saving of the bulk of whatever remains in the impurities separated out. . . ."
>
> "In the hopper the material has oil, either coal-oil or any other suitable kind, sprayed upon it from a pipe 27 and the mixed graphite, sand, &c., escapes through a chute 28 into a washing-tank 29, containing a rotary agitator 30, driven by a belt 31, from the upper shaft 32 of the conveyor 22, the water of

the tank 29 being kept at boiling heat by steam supplied through pipes 32^a. The lighter particles of graphite separated by the agitator and that float on the surface of the water in the washing-tank are removed by a skimming device 33 and are discharged into a tank 34, containing water, whence they are removed."

No. *777,273*, granted December 13, 1904, to Arthur E. Cattermole.

This is one of the patents referred to in the patent in suit. I quote therefrom as follows:

"The present invention relates to improvements in the separation of the metalliferous constituents of ores and the like from gangue by means of the selective action of oils and certain tar products or similar compounds (all hereinafter referred to as 'oil') on metallic or metalliferous matter.

"The invention depends upon the application of the following facts: First, when a mixture of powdered metalliferous matter and gangue is treated with oil suspended in water—that is to say, in emulsion—the oil has a more or less selective action and will coat the particles of metalliferous matter in preference to the particles of gangue, while the particles of gangue will be wetted by the water; second, if the water which is mixed with the oil is acidulated with mineral, fatty, or other acid the selective action of the oil will thereby be rendered more marked and decisive; third, if the proportion

of oil is kept within reasonably low limits (differing in different cases, according to the nature of the mineral to be treated and the consistency and nature of the oil) and if the mixture of water, oil, metalliferous particles, and gangue be thoroughly agitated the metalliferous particles which have become coated with oil will adhere together and form granules, which granules, partly by reason of gravity or partly on account of their bulk, as compared with the individual grains of gangue, will offer ready means for separation in an up-current separator, a jig, or other similar appliance. This action is facilitated if the oil before addition to the liquor is brought into the condition of an emulsion in water containing a small percentage of soap or other emulsifying agent. These facts are utilized for the purpose of separating the metalliferous constituents from the gangue of the ore in the following manner: In a suitable apparatus, an example of which will be hereinafter described, the ground or pulped ore is caused to be violently agitated, as by a revolving stirrer, in a mixture of water and oil, the liquor being acid. As the agitation proceeds the particles of metalliferous matter agglomerate together and may be observed in the form of granules, the size of which will depend, among other things, upon the percentage of oil used. . . ."

"A series of connected mixing vessels A' A^2 A^3 A^4 A^5 A^6 are provided with stirrers B, rotated

from driving shafts B′. Crushed ore from a hopper C and water from a tank D are introduced into the first vessel, A′, and oil or emulsion is fed from a tank E, through pipes E′ E^2 E^3, to the various vessels. The mixture is vigorously agitated to break up and emulsify the oil and to bring about intimate contact of the divided oil with the metalliferous mineral particles and of the oiled particles with each other. It is found under these conditions the metalliferous mineral particles abstract the oil and become coated with a thin oily film, which is insufficient to materially lessen their specific gravity, and that under agitation such slightly-oiled particles adhere, nucleate, and agglomerate into small more or less rounded masses or granules disseminated throughout the mass of gangue, which remains free and practically devoid of oil. In order to maintain the liquid mass in which the separation is affected in an acid condition, a small proportion of the sulfuric or other acid is introduced into one or more of the vessels from a tank F, having discharge-pipes F^3 F^4 F^5 F^6. . . ."

"The proportion of oil used depends upon its viscosity, the fineness of the ore and other factors, and the consistency and size of the mineral granules desired. The more oil used the larger, softer, and less numerous the granules. With, say, ten per cent. of oil to the weight of metalliferous mineral a few pasty masses of oil-agglomerated metalliferous mineral matter will generally result. Oil in

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excess of this may cause all the granules to coalesce into one soft mass. Usually the amount of oil varying from four per cent. to six per cent. of the weight of metalliferous mineral matter present in the ore yields granules of suitable size, consistency, and specific gravity for ready separation from the gangue in the up-current or other apparatus used for classification. . . ."

"The 'oil' used may be animal, vegetable, or mineral oil or mixtures of these or such coal or wood tar products or other substances which exercise, like oils, a preferential physical affinity for metallic mineral matter as distinguished from gangue. . . . ."

"It has been found that if the water in which the operation is conducted contains a percentage of acid varying in the case of sulfuric acid of 1.84 specific gravity from one-half of one per cent. to a tenth of one per cent., the operation is greatly facilitated. Indeed, if there is no acid present there is a great tendency for the oil to coat the gangue or some portion of the gangue, as well as the metalliferous particles. It is preferable to use water acidulated with about one-fifth of one per cent. of this acid, and it is found in practice that such a degree of acidulation is sufficient completely to prevent the gangue from being oiled, while it is not, generally speaking, enough to cause the water to act chemically upon the metalliferous matter.

"I am aware that the selective action of oils and

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> the like on metallic matter has been made the basis of previous processes for separating the metalliferous constituents of ores from gangue. For example, oil has been used to float off metalliferous mineral from ore-pulp, and its use has also been proposed to form a pasty mass of crushed ore from which the gangue could afterward be washed out by means of water, and I do not claim the employment of oil in any such manner. . . ."

Summarized, this patent disclaims as old, but utilizes the selective action of oils for the metalliferous constituents of ores. It describes, but does not claim as new, the use of acid, such as sulfuric acid, to increase the selective action of the oil and prevent it from coating the gangue. It notes that a small amount of acid, for example, a fraction of 1 per cent. on the amount of water in the pulp, is sufficient. It directs violent agitation of the mixture of pulp, oil and acid, and illustrates for this purpose a series of connected vessels each containing a revolving cone, the precise type of agitator adopted in the patent in suit. The percentage of oil specified is based on the weight of the metalliferous minerals that are present in the ore and not on the ore itself. Apparatus of the spitzkasten type is used to separate the lighter from the heavier material, after agitation with oil and acid, and the bulk of the water is returned for re-use in the process.

Adjourned until Friday, May 3, 1912, at 10 A. M., same place.

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May 3, 1912.

Met pursuant to adjournment. Present, counsel as before.

Direct examination of Eugene A. Byrnes continued.

Answer to Q. 4 continued.

No. 776,145, granted November 29, 1904, to Charles V. Potter. I quote from this patent as follows:

"The object of my invention is to separate metals from sulfid ores by an expeditious, effective, and inexpensive means and method.

"The crude ore, concentrates, tailings, or slimes after being pulverized are placed in a suitable vat or vessel and a solution is then added, such solution consisting of water with the addition of from one per cent. to ten per cent. of any acid (preferably sulfuric acid, for reasons hereinafter stated), the acidulated strength of the solution being determined by the quality or nature of the sulfid ore to be treated. The small quantity of acid added does not act as a solvent.

"Ores containing lead, zinc, copper, iron, gold, and silver in combination with sulfur I treat as follows: The ore in a state of fine division is placed in a vat or such like vessel provided with an internal stirrer or stirrers. The acidulated solution is then added thereto, such solution containing in the first instance, say, one per cent. only of the acid when mixing it with the ores, and after heat is ap-

plied thereto, as hereinafter directed, gradually increasing its acidulated strength until the determinate strength is reached, which in most instances will amount to two and a half per cent. of acid, or thereabout, to be decided on or governed by the apparent action of the solution on the material under treatment. Heat being applied, the effect of the acidulated solution becomes apparent by the bubbling up and gathering on the surface of the fluid of the metallic concentrates in the form of a pasty mass. Should this pasty substance be scanty, thin, and not swell and accumulate rapidly, so as to overflow the vat if not skimmed off, more acid must be added until the maximum separative activity is reached, which very slight experience and observation in applying this treatment to sulfid ores will enable the operator to determine. . . .

"The stirrers are then freely used, and heat is applied to the vat or vessel directly or by means of steam injection therein at or near the floor of the vat or vessel. As the temperature of the solution and other contents of the vat or vessel rises it causes the metals to rise upward from the bottom of the vat and float upon the surface, from which it may be allowed to flow automatically and continuously into a separate receptacle or be skimmed off, as arranged, into a separate vessel for further treatment. The gangue accumulating in the bottom of the separating-vat, containing a small proportion of gold and silver, as well as all the rhodonite, garnets, silica, . . ."

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The process of this patent is similar to that of the Delprat patent No. 735,071, heretofore referred to by me, except that the pasty mass containing the metallic concentrates which is removed by overflow or skimming, is formed by the action of sulfuric acid, stirrers, which "are freely used," and heat, which may be that of steam injected into the agitating vessel at or near its bottom. The agitating vessel illustrated in the drawing and described, consisting of a vertical shaft carrying four radial stirrer arms at its lower end and rotated by gears at the upper end, is practically identical with that used by the defendant in this suit and shown by him in his recent U. S. process patent No. 1,022,085, dated April 2, 1912. The free use of an agitator of this type causes the solution to become thoroughly aerated and impregnated with fine air-bubbles which would assist the gas chemically generated by Potter in forming a pasty floating mass carrying the concentrates. Potter indicates that the effect of the applied heat is to increase the generation of gas by the action of the acid on the ore.

No. 777,274, granted December 13, 1904, No. 788,-247, granted April 25, 1905, to Arthur E. Cattermole, Henry L. Sulman and Hugh F. Kirkpatrick-Picard. The first of these patents is referred to in the patent in suit as describing the optional method of liberating the oleic acid used for oiling the mineral "*in situ* in the pulp by decomposing a dilute soap solution with mineral acid." The applications for these two patents were filed simultaneously, and the description of the method of

oiling the mineral by a fatty acid, etc., liberated from a soap solution added to the pulp is almost identical in both, lines 10 to 56 of page 1 of the first patent being nearly the same as lines 9-53 of page 1 of the second. The first patent then describes separation of the oiled mineral from the gangue by the use of the process claimed in the Cattermole patent 777,273, heretofore considered by me, that is, by causing the coated metalliferous particles to adhere together and form granules or small agglomerated masses, which are separated from the gangue in an up-current device, the metalliferous granules settling while the gangue is carried upward. The claims of this first patent cover the oiling of the mineral by an organic or fatty acid liberated from soap, followed by separation of the oiled mineral by agglomeration.

The description of the second of these two patents, following line 53 of page 1, is more general as to the mode of separating the oiled mineral particles from the gangue. I quote therefrom as follows:

> ". . . The mineral particles now attached to or more or less coated or inclosed by films of fatty or resin acids and the like are capable of being separated from the gangue or earthy particles by various methods dependent uopn this altered physical condition. For example, the coated mineral particles may be removed by generating gaseous bubbles in the mixture which preferentially attach themselves to the fatty or similar acid-coated particles and raise them to the surface of the pulp, whence they may

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be removed by skimming or the like. If the ore contains a carbonate, any small excess of the acid used to decompose the soap or similar alkaline compound will also liberate bubbles of carbonic acid, which will attach themselves to the fatty acid-coated mineral particles and float them to the surface, or a suitable carbonate (or other substance capable of liberating a gas on the addition of a suitable acid, such as an easily decomposable sulfid, &c.) may be initially added to the ore mass for such purpose, or the mineral particles may be caused to adhere to metallic or other suitable surfaces coated with similar fatty acids, or, finally, the coated mineral particles may be caused to adhere to wood, sawdust, or other suitable material lighter than water coated with similar fatty acids, &c., which can then be removed by flotation, in each case leaving the mineral-free gangue particles capable of rejection. . . ."

The first two claims of this second patent cover the process of oiling the mineral by an organic acid liberated from a soap solution, followed by separation of the coated material from the non-coated gangue in any manner whatever. The remaining claims, 3 and 4, cover the same mode of oiling the mineral, followed by the separation of the oiled mineral by gas-flotation. The language of claim 3 as to this feature is as follows:

"bringing the liquor into intimate contact with a gas which will adhere to the coated particles and separating out the coated mineral matter which floats."

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The flotation of the oiled mineral by "generating gaseous bubbles in the mixture," that is, by bubbles of carbonic acid liberated from an ore containing a carbonate by the action of an acid, was well known prior to the filing date of this second patent, having been described in British No. 12,778 of June 4, 1902, to Alcide Froment. The liberation of a gas by the action of an acid on a sulfid in the ore was also well known, being characteristic of the prior Potter and Delprat methods, to which I have referred. The flotation of mineral particles by causing them to adhere to wood, sawdust, etc., had also been described in U. S. patent 471,174, granted March 22, 1892, to Charles B. Hebron and Carrie J. Everson. Reference was doubtless intended by the matter quoted from this second patent 788,247 to these prior methods, well known to those skilled in the art.

No. 793,808, granted July 4, 1905, to Henry L. Sulman and Hugh F. Kirkpatrick-Picard, on an application filed October 5, 1903. I quote from this patent as follows:

> "The present invention relates to the concentration of ores by separation of the metalliferous constituents and graphite, carbon, sulfur, and the like from the gangue by means of oils, grease, tar, or any similar substance which has a preferential affinity for metalliferous matter over gangue.
>
> "According to this invention we utilize the power which is possessed by films or bubbles of air or other gas of attaching themselves to solid particles moistened by oil or the like.

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"According to one method of carrying out our invention suitably-crushed ore is suspended in water. To this suspension a proportion of oil, grease, or tar (hereinafter referred to as 'oil'), is added and duly mixed with the mass by any suitable means in quantity insufficient to raise the oiled mineral by virtue of the flotation power of the oil alone. A suitable gas is now generated in or introduced into the mixture, such as air, carbonic-acid gas, sulfureted hydrogen, or the like. For example, bicarbonates or carbonates, either soluble or insoluble in water (preferably the latter) or easily-decomposable sulfids and the like may be used with acid solution. In such cases, if desired, the addition of acid may be made to the mixture after the addition of the gas-producing reagent. In the case of solutions containing free alkali the addition of acid sufficient to neutralize this must be made before the gas is produced. If desirable, gaseous bubbles may be produced by electrolytic methods or by means of various other known reactions.

"According to another method of carrying out this invention the oil is not added alone but the pulp is submitted to the action of a current of air or other gas bubbles, the air or other gas being first suitably charged either with the vapor of a volatile oil, such as petroleum of low boiling-point, or with the spray of any other suitable volatile or non-volatile or fixed oil or the like. The oil may be sprayed or reduced to a state of such fine division that minute

globules of the same can remain temporarily suspended in an air or other gas current by the use of any suitable spraying or atomizing device and the air-current introduced into the ore-pulp, preferably at the bottom, by means of a pipe or pipes provided with suitable perforations or by other suitable contrivance. The minute oil globules or the condensed vapors or volatile oils attach themselves to the metalliferous particles in preference to the gangue.

"The oiled metalliferous particles resulting from either of the processes above described have the power of attaching to themselves with a greater comparative strength than the gangue particles the films or bubbles of gas which exist in the mass and are thus raised to the surface of the liquor by gaseous flotation. They can then be removed by skimming or other suitable means. The gangue particles unwetted by oil or grease are not floated up with the oiled mineral particles, and thus in the main remain at the bottom of the vessel containing the mixture. The oil can then be removed from the oiled mineral by any suitable known means.

"In the case in which oil-spray is used the temperature of the mass of pulp may be varied to secure the best results with spray of oils of varying viscosity. Instead of suspending the oil-spray in an air-supply system suitably-devised atomizing-jets operated by air or a jet of steam and air may be introduced directly into the pulp. The gas used may be other than air, such as carbonic acid, steam,

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or mixtures of these. We have also found that a particle of metalliferous mineral if coated with a minute film of oil, grease, or the like then exposed to air will not readily sink in water. It is therefore unnecessary in some instances to employ gaseous bubbles to effect flotation. For example, according to an alternative method for effecting the separation of metalliferous matter from gangue the metalliferous ore-pulp is intimately mixed in any suitable matter with a small proportion of oil and then sprayed in as finely divided a state as necessary through air by means of jets, revolving disks, or otherwise, and the sprayed product is then allowed to fall upon the surface of water. The gangue particles wetted only with water at once sink, while the metalliferous particles coated with a thin film of oil and after exposure to air float on the surface of the water and may be removed by skimming or other suitable means."

Three forms of apparatus are illustrated for carrying out the process, according to some of the various modifications thereof which have been described:

Figure 1 shows an apparatus comprising a long tank having an inclined bottom, just above which is supported a coiled perforated pipe, journaled at its ends in bearings in the end-walls of the tank. The ore-pulp is fed into the shallow end of the tank, and a mixture of air and oil, that is, compressed air carrying a spray or vapor of oil, is forced into one end of the coiled pipe

and thence through its numerous perforations into the pulp in the tank. This apparatus is well adapted to preferentially coat the metalliferous constituents of the ore with a minute film of oil insufficient to itself raise the mineral, and also to attach to the oiled mineral particles films or bubbles of air to float them as a froth, which is then discharged over the top of the end-wall of the tank into a launder, the unoiled gangue remaining at the bottom of the tank whence it may be withdrawn through a tap. The coiled perforated pipe will also act as an efficient agitator to entangle and intermingle a considerable amount of atmospheric air with the pulp, assisting the aeration. The patentees note that different oils may be used of varying viscosity, and provide for varying the temperature of the pulp to secure the best results, it being obvious that an oil which is thick or solid at ordinary temperatures would necessitate heating of the mass to render it sufficiently fluid to coat the mineral particles with a minute film of oil sufficient to cause them to adhere to films or bubbles of air or gas.

Figure 2 of this patent illustrates another apparatus in which oil is first mixed with pulp and the aeration of the oiled mineral particles to form the froth of concentrate is effected by passing the mixture of pulp and oil through an ejecter supplied with compressed air. The oiled and aerated pulp is then delivered onto a froth-separator consisting of a series of funnel-shaped vessels of progressively increasing size, like those employed in the patent in suit, the metalliferous froth

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floating onward over the upper edges of the vessels into a launder, and the gangue, classified in different sizes, settling in the several vessels and thence being discharged through taps at the bottom.

Figure 3 illustrates an apparatus in which oil is first mixed with the pulp, and the aeration to form the metalliferous froth is effected by flowing the mixture in a thin layer over a revolving disk, the oiled and aerated pulp being thence discharged into a concentric series of annular V-shaped troughs, the froth flowing outward to a discharge launder and the gangue settling to the bottom of the troughs and being thence discharged.

The patentees refer to the known method of chemically generating a gas to float the oiled particles, by the action of acid on carbonates or sulfids, as practiced by Froment, Potter and Delprat; also to the evolution of gaseous bubbles by electrolytic methods, that is, by the decomposition of a portion of the liquid into its gaseous elements by the passage of an electric current through it.

This patent to Sulman and Kirkpatrick-Picard, two of the three alleged joint inventors of the patent in suit, as well as number 788,247 heretofore discussed, granted jointly to Sulman, Kirkpatrick-Picard and Cattermole, clearly discloses the following facts:

(1) The preferential affinity of oils, fats and the like for mineral particles rather than gangue.

(2) The preferential affinity of the oiled mineral particles for films or bubbles of gas, however supplied to the pulp.

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(3) The flotation and removal of the oiled and aerated metalliferous particles as a froth.

(4) The addition of acid to a pulp of ore containing carbonates or sulfids capable of reacting with the acid.

No. 793,808 provides for varying the temperature of the mixture of the mass of pulp, dependent on the viscosity of the oil used; it also illustrates in Figure 1 an apparatus employing an efficient agitator, and in Figure 2 the precise froth-separator of the patent in suit, except for the up-currents of water in the spitzkasten, commonly used.

No. 807,501, No. 807,503, granted December 19, 1905, to Alfred Schwarz.

I quote from the first of these patents as follows:

> "In the concentration of ores by the employment of hydrocarbons as adhesive agents it has been observed that sulfids yield better results than oxids, carbonates, and chlorids. In fact, so far as known to me, a practical application of such process before my inventions relating to this art has been largely, if not wholly, confined to sulfid ores. . . ."
>
> "Of hydrocarbons which are solid at normal temperatures and required to be melted there may be used paraffin or ozocerite, or a resinous hydrocarbon, such as resin, pitch, or asphaltum. Of normally liquid hydrocarbons there may be used any suitable vegetable, animal, or mineral oil.

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These hydrocarbons may be used singly or in combination of two or more, it being understood that the constitution of the adhesive agent will depend upon the character of the ore to be treated, varying as the ore varies.

"Ore either in a dry or wet condition is mixed in any suitable vessel having an agitator with the hydrocarbon, sufficient quantity being added to effect the desired separation. If the hydrocarbon is one which is solid at normal temperatures, it is first melted and then stirred in with the ore, the mixture being effected by any suitable mechanical means and, if desired, air, steam, or gas may be injected into the mass either alone or to assist the mechanical agitation. The injection of such gaseous agent results in the hydrocarbon taking up an appreciable quantity of air or gas, giving a certain sponginess which increases its floating power.

"As a specific example of my invention I have used as an adhesive agent a mixture of paraffin and resin, heat being employed if necessary to maintain this compound in a melted condition after it has been mixed with the ore.

"After an intimate mixture with all parts of the ore has been effected the mass is subjected to the action of water heated to any desired temperature, even as high as the boiling-point, whereby the earthy or rocky constituents are liberated and washed out and settle in the bottom of the

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vessel. The metallic constituents of the ore having united with the adhesive agent may be skimmed or screened off and run to a centrifugal drier for the separation or recovery of the concentrates from the adhesive agent. . . ."

I also quote from the second of these patents as follows:

"Heretofore the separation of the values in ores has been effected by mixing the pulverized ore with a product resulting from the distillation of petroleum, the ore having been previously mixed with sufficient water to form a freely-~~floating~~ flowing pulp. The oil in such method exercises the property of attaching itself to and buoying up the metallic constituents of the ore that are suspended in the pulp; but it has little or no effect upon the earthy constituents. I have found that the efficiency of the selective action of oils generally, either mineral, vegetable, or animal, is increased by the addition thereto of a fatty matter which is solid at normal temperatures, as paraffin, stearin, or palmitin.

"In carrying out my invention I proceed as follows: The ore is first crushed and screened to a convenient size for working and is then thoroughly and intimately mixed with the selective material, which in this instance is a compound of mineral, vegetable, or animal oil and a fatty matter of the character above specified, such mixture

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being solid at normal temperatures. Such material may be readily prepared by dissolving the fatty matter in the oil medium, heat being employed to melt the fatty matter, if necessary, and to maintain the compound in a liquid condition during its incorporation with the pulverized ore. As a specific example of a selective material I prefer crude petroleum or any of its products, to which is added about nine to ten per cent., by weight, of paraffin, such proportion having been found to give good results with a copper-sulfid ore.

"Any suitable apparatus may be employed to effect the mixture of the ore and selective material, all that is essential being a vessel provided with agitating-blades. In such vessel the ore is mixed with sufficient of the selective material to make a thick pasty mass, the agitation being continued long enough to bring the selective material into intimate contact with all portions of the ore. The vessel may be steam-jacketed or otherwise suitably heated if found necessary to maintain the selective material in a liquid condition. After a complete incorporation of the selective material with the ore water, preferably under pressure, is injected into the mass by suitably-arranged pipes and agitation continued until the water is distributed throughout the mass. The mass is then allowed to subside, when the selective material, with the entrapped metallic con-

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stituents of the ore, will rise to the top and may be removed in any suitable manner, as by floating over the top of the vessel. The values may be separated from the selective material in any suitable or well-known manner—as, for example, by a centrifugal drum or filter-press. The tailings, being unaffected by the selective material, will remain in the water and settle to the bottom of the vessel, from which they may be drawn off and, if necessary, subjected to further treatment for the recovery of any values they may contain.

"In the concentration of ores by the selective action of the compound above described the action is facilitated and better results secured by the injection of a gaseous fluid—such as air, steam, or gas as carbon-dioxid gas—into the mass. This may be done by suitably-arranged pipes leading into the bottom or sides of the vessel, the effect of such use of air, steam, or gas being to break up and subdivide the mass in a complete and thorough manner. Furthermore, it results in the selective material taking up an appreciable quantity of air or gas, giving a certain amount of sponginess, which increases its floating power. . . . .

"1 designates a bin or hopper from which the pulverized ore is discharged into a vessel 2, which is preferably steam-jacketed and provided with an agitator 3. In this vessel the ore and selective agent are intimately mixed, and from said vessel the mass is discharged into a vessel 4, provided

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with an agitator in which it is treated with water slightly acidulated, if desired, to effect the separation of the selective agent, with the entrapped metallic constituents, from the tailings. If cold water is employed, the selective agent will be solidified and rising to the top is conducted by a trough 5 to a remelting and storage vessel 6. If heated or boiling water is employed in the vessel 4, the selective agent will be maintained in its liquid condition and as it rises with the entrapped metallic constituents is run by the trough 5 into the storage vessel 6 and from the latter to a centrifugal-drum 7 for the separation of the values from said agent. The recovered agent is collected in a storage vessel 8, from which it may be raised to the mixing vessel 2 by a pump 9. The separating vessel 4 is provided with suitable pipes 10 for the admission of air, steam, or gas and with a pipe 11 by which the tailings may be discharged into a vessel 12. . . ."

These patents disclose the following points:

(1) The selective action of oil generally, mineral, vegetable or animal, for the metalliferous constituents of ore, especially sulfid ores.

(2) The use for oiling the mineral of an oil containing a fatty matter which is solid at normal temperatures, such as stearin; and of a mixture of an oil, which may be animal oil, and a fatty matter, which may be stearin,

which is solid at normal temperatures. "Red-oil," the commercial form of impure oleic acid produced by the candle and soap-maker, is a mixture of this character, containing stearic and palmitic compounds, and being entirely solid at the lower range of atmospheric temperatures.

(3) The use of a sufficient quantity of the oil or oily mixture to effect the desired separation, that is, the oiling and floating of the metalliferous constituents.

(4) The use of slightly acidulated water to prevent the adhesion of the oil or oily mixture to the gangue or tailings, that is, to increase its selective action or preferential affinity for the mineral.

(5) The thorough mechanical agitation of the ore with the oily material and with the acidulated water, as by agitating blades, in open vessels, which agitation will not only thoroughly distribute the oil throughout the ore and cause it to coat the mineral particles, but will also entangle the atmospheric air and thoroughly aerate the mixture to produce a floating froth of concentrates.

(6) Further aeration of the mixture by the injection of streams of air, steam or carbon dioxide gas, giving the froth sponginess and increased floating power, thus floating some of the oiled mineral which might otherwise

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remain in the tailings and necessitate their re-aeration in a subsequent operation.

(7) The heating of the mass, as by steam-jacketing the agitator vessel, or ~~being~~ using heated or boiling water, to maintain the oiling agent in a liquid condition.

(8) The flotation of the aerated and spongy mass of the selective material, or oiling agent, with the entrapped metallic constituents of the ore, and its delivery to a centrifugal filter, the tailings being settled out and withdrawn at the bottom.

(9) The retreatment of the tailings, if necessary, for the recovery of any values therein contained.

No. 809,959, granted January 16, 1906, to Edmund B. Kirby, on application filed December 14, 1903. I quote from this patent as follows:

> "The invention relates to the concentration of ores. It may be employed to separate the metallic minerals from the gangue, or to separate certain of the metallic minerals from others or from others and the gangue.
>
> "The operation of the process is dependent upon the fact that, because of differences in physical characteristics of the various constituents of mineral material, such contsituents show preferences of adhesion between two commingled, but immiscible liquids. . . .

"The process, as an entirety, in its best form for use with Rossland ores for the purpose stated consists in the following steps:

"First, in thoroughly agitating together (*a*) the pulverized ore or mineral material, (*b*) enough water to make with said pulverized ore a flowing pulp, and (*c*) a solution of bitumen in a thin distillable hydrocarbon liquid as kerosene, these materials to be so thoroughly agitated together as to finely subdivide said solution into small globules and bring said globules into contact with substantially all of the pulverized mineral particles which will, by preference, adhere to them.

"Second, in allowing the hydrocarbon-coated particles to float to the surface of the mass, and in rendering this separation substantially complete by gently agitating the mass, and by injecting gas into the same, and preferably also discharging into the mass fine streams of the solution. When the separation is completed, the floating hydrocarbon-coated concentrate is removed for subsequent treatment.

"Third, in filtering said concentrate to free it so far as possible from the hydrocarbon liquid.

"Fourth, in distilling said coated concentrate and condensing the hydrocarbon vapor to be used again.

"It is thought that the use of a gas to assist in the flotation of the coated particles, as set forth in the description of the second step of the pro-

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cess, is radically new in this art, irrespective of its association with the other steps described. It is that which makes it possible for the first time to use thin oils and hydrocarbon. . . .

"The employment of the gas in the manner stated brings in a more powerful floating agency than anything before used, which results in the recovery of this floured oil together with numerous coated particles which would not otherwise be floated. This step of the process is therefore useful with any and all liquids lighter than water which exhibit preference of adhesion for the metallic mineral particles. Kerosene alone, for example, may be used with most ores to take out the sulfids provided the gas is used, as stated, to cause the flotation of the kerosene-coated particles. . . .

"Preferably the pulverized ore is mixed with three to five times as much water, by weight, and to this is added a sufficient amount of the kerosene-bitumen solution, excellent results being obtained by using one-fourth to three-fourths as much, by weight, as ore. The preference of the solution for some of the mineral particles may be regulated by altering or varying the quantity of the solute substance and by varying the temperature at which the solution is used. The preference of the water for other mineral particles may be regulated by adding some acid or other chemical. . . .

"The injection of a gas, preferably air, into the mass, which is the chief novel characteristic of the second step of the process, assists in the flotation of the hydrocarbon-coated particles. This makes it possible to finely subdivide the solution by the agitation, and this greatly increases the chance that all of the mineral particles which exhibit preferential adhesion for it shall be brought into contact with it. Some of the hydrocarbon-coated particles will float to the surface without assistance; but a considerable quantity of such particles will not be sufficiently buoyant, and some of such particles and some globules of the mixture would be trapped in the sands. In order to recover this less buoyant material together with the globules of the mixture, the mass which tends to settle is slowly lifted and turned over to liberate the coated particles and the globules, and at the same time a gas, preferably air, is blown into the mass preferably near the bottom thereof. The air-bubbles not only tend to attach themselves directly to the coated particles, and thus float them to the surface, but the air becomes dissolved in the water to its maximum capacity. This dissolved air tends to again separate itself from the water and attach itself in minute globules to the coated particles. I find that air, carbon dioxid, hydrogen, and marsh-gas are satisfactory for this purpose, and doubtless many other or all gases will

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operate in the same way, but I prefer air. . . . ."

Adjourned until Monday, May 6, 1912, at 10 A. M., same place.

WASHINGTON, D. C., May 6, 1912.

Met pursuant to adjournment. Present, counsel as before.

Direct examination of Eugene A. Byrnes continued.

Answer to Q. 4 continued.

Complete apparatus is illustrated for carrying out the process, comprising an open vessel A termed a "mixing-tank." In this tank is centrally journaled a vertical shaft *a*, to the lower end of which are attached four radial arms having agitating blades. A reservoir M having a valved outlet is provided to hold the oil or oily solution and deliver the proper regulated amount into the tank. In use, the "shaft *a* is to be rotated rapidly, and the result is a thorough commingling of the various parts of the charge," that is, of the pulp of water and ore, the oil, and the acid which may be used to assist the preferential affinity of the oil, the temperature being varied to also regulate the preference. The thoroughly agitated and commingled mixture is then delivered from tank A into an open vessel B termed a "separating tank." A vertical central shaft having four radial arms with stir-

ring blades is also journaled in this tank. The arms are here provided with small depending pipes for delivering streams of air and oil into the mixture. Upon rotation of the shaft and the injection of more oil with streams of air, some of the metalliferous particles which had not been sufficiently oiled and aerated to float in the first mixing-tank, but which remain trapped in the sands or gangue, will be rendered buoyant and will float. It is noted that not only will the streams of injected air form bubbles directly attaching themselves to the oiled particles, but that some air will become dissolved in the water and again separate in minute globules attached to the oiled particles. Kirby states that the first tank A may be omitted, its function being then performed in the second tank B. For this purpose, the agitator in tank B is rapidly rotated to thoroughly mix the (acidified) ore-pulp with the oil, and to oil and aerate the mineral. The agitator is then rotated slowly, with injection of air, etc., whereupon the oiled and aerated mineral rises to the top and floats as a froth. The slow agitation of the mass at this time liberates buoyant particles mechanically held therein. The froth of concentrates is now directed by a curved skimming bar 38 into a settling and washing chamber or box 29 arranged near the top and at one side of the tank B. This settling device comprises a series of funnel-shaped compartments, of progressively increasing size, of the spitzkasten type, the last of these compartments having a pipe 35 to deliver an up-current of

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water therein and a gate 32 to deliver the froth to a launder. Tailings are discharged from openings at the bottom of the compartments, falling down to the bottom of the tank B. The froth or concentrate is delivered to filtering apparatus, and the filtered concentrates may be heated to distill off and recover the oil, the use of a thin distillable oil being one of the features described and claimed as novel.

No. 838,626, granted December 18, 1906, to Edmund B. Kirby, on application filed December 17, 1903. I quote from this patent as follows:

> "The object of this invention is to effect with substantial completeness the segregation of those pulverized mineral particles which have a prefenential adhesion for water from those which have a preferential adhesion for a liquid immiscible in water—for example, oil, or a solution of bitumen in kerosene.
>
> "This invention is for the treatment of the charge after the pulverized mineral, the oil or solution, and the water have been thoroughly mixed together, whereby nearly all of the mineral particles which exhibit adhesive preference for the oil or solution have been coated therewith.
>
> "The invention is most useful when used to carry on one step of a process of my own invention, wherein the immiscible liquid employed is thin and light—as, for example, a solution of bitumen in kerosene; but the invention is also use-

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ful with oil processes for separating mineral particles. . . .

"The tank A is preferably cylindrical. Into it is to be charged the materials to be separated—to wit, pulverized ore, water, and some liquid lighter than water and immiscible therein, which will adhere only to the metallic mineral part of the pulverized ore—said materials having preferably been thoroughly mixed in another tank. The immiscible liquid may, as stated, be oil or a light hydrocarbon, or a solution of bitumen in a light hydrocarbon. The apparatus was especially designed for use with a charge consisting of ore, water, and the solution of bitumen in kerosene, and therefore the immiscible liquid will for convenience of description be referred to herein as the 'solution.' The charge should be very fluid and should preferably contain three or four times as much water as mineral, some of which water may be added to the mixture after it has been transferred to the tank A.

"Most of the solution and the solution-coated mineral particles rise immediately to the surface, from which they may be skimmed; but considerable quantities of the solution-coated concentrates are enveloped by and entrapped in the sands which settle to the bottom of the tank. For the primary purpose of freeing these particles from the sand and permitting them to float on the surface the vertical rotating agitator-shaft

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B and its adjuncts are provided. Arms D are secured to this shaft near the bottom of the tank, and as the shaft slowly rotates they gently lift the mass of sands from the bottom and overturn it and prevent it from packing, and thus permit the solution-coated particles to escape and float to the surface. . . .

"It is very desirable that some gas, preferably air, shall be blown into the charge near the bottom thereof. This gas assists in agitating the charge; but its chief value is in the assistance it renders in floating the solution-coated particles to the surface. It is clear that some of these particles may be so large and heavy that the coating thereon may not be able to buoy them up, this being especially true in case the liquid used is thin and light, as the kerosene-bitumen solution. The gas-bubbles, however, not only tend to attach themselves to the solution-coated particles and to buoy them up after the fashion of balloons, but the water is caused to dissolve the gas to its maximum capacity. This dissolved gas tends to again separate from the water and attach itself in minute globules to the solution-coated particles, thus buoying them up and assisting their flotation.

"It is thought that any gas which will not chemically combine with the charge may be employed in the manner and for the purpose stated; but it is definitely known that air, carbon dioxid, hydrogen, and marsh-gas may be so used, air appearing

to be rather the most efficient, as well as the cheapest. This gas may be injected in any way and by any means; but very efficient means for this purpose are shown in the drawings, said means consisting generally in making the shaft B and arms D hollow and providing the latter with discharge-openings and blowing the gas down through the shaft. . . .

"The solution is delivered from the pipe K to a series of radiating pipes *k*, which are secured to the arms D, and is discharged from branch pipes *k'*. This solution tends to attach itself to those particles not already coated, but which it will adhere to, and thus assists their flotation. The introduction of air and solution renders the separation substantially complete—that is to say, it causes substantially all of the particles which exhibit preferential adhesion for the solution to become coated thereby and floated to the surface. . . ."

The apparatus illustrated in the drawings of this patent is substantially identical with the "separating-tank" B of the preceding Kirby patent 809,959, except that two skimming-bars P are shown, and two perforated pipes T for directing air-jets onto the floating concentrates to direct it to and carry it over the settling compartment.

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These two Kirby patents show the following points:

(1) The selective action or preferential adhesion of oils generally, and especially kerosene or a solution of bitumen in kerosene, for the metalliferous constituents of ore, kerosene being specified as useful with sulfid ores.

(2) The use of "a sufficient amount" of the oil or oil solution to attain "excellent results" in the separation of the mineral by flotation.

(3) Varying the temperature at which the solution is used to regulate the preferential affinity.

(4) Adding acid to regulate the preferential affinity.

(5) The thorough mechanical agitation of the ore-pulp, acidulated, and the oil, by a rapidly rotating shaft having radial agitating blades, which type of agitator, employed by the defendant in this suit, is found to be a most efficient one for intermingling atmospheric air with the mass and thoroughly aerating the oiled mineral to produce a floating froth of concentrates.

(6) Further aeration of the mixture by the injection of streams of air or gas, such as carbon dioxid, hydrogen, or marsh-gas, acting to float the less buoyant, larger and heavier mineral particles trapped in the tailings, the separation of the froth of concentrates from the tailings by floating the scum over a series of vessels of the spitzkasten type, of progressively-increasing size with an up-current of water, and the delivery of the concentrates to a filter.

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I will next refer to a British patent, No. 12,778, granted June 4, 1902, to Alcide Froment, corresponding to his Italian patent No. 62,723. I quote from this British patent as follows:

"The following phenomena, studied by the inventor, have served as the basis of the process which forms the subject of this invention.

"1. When the natural sulphides reduced to powder are moistened by a fatty substance, they have a tendency to unite in spherules and to float upon the surface of water.

"2. This tendency is simply retarded by the specific weight, and opposed by the gangue which imprisons the moistened sulphides in its pulverulent mass.

"3. If a gas of any kind is liberated in this mass, the bubbles of the gas become covered with an envelope of sulphides and thus rise readily to the surface of the liquid where they form a kind of metallic magma.

"4. The formation of these metallic spherules is singularly active if the gas is in a nascent state.

"Thus for example, if in a test tube there is placed ten grammes of sulphuretted copper ore with its gangue, a gram of limestone, the whole reduced to powder, and if there is added thereto thirty grammes of water, a few drops of sulphuric acid and a thin layer of ordinary oil, and the mixture then agitated for a brief space, the whole of

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the chalcopyrite will instantly rise to the top of the liquid. The metallic spherules, pressed one against the other, will become grouped in a magma clearly separated from the rest of the liquid. If the limestone is in excess or readily attackable, the rapidity of the separation is so great that the chalcopyrite is forcibly projected outside the vessel. There is therefore a proportion to be sought for a given ore and limestone.

"The small quantity of gangue mechanically conveyed gradually falls and the sulphides remain in a state of almost complete purity. Such is the principle.

"Thus, the rapidity of the formation of the spherules and their ascension is in direct ratio to the quantity of gas produced in a given time.

Example 1.

"A cuprous ore containing 12% of chalcopyrite, 15% of iron pyrite, 20% of carbonate of iron, 16% of dolomite and calcite and 37% of various gangues have been submitted to my said process. It should be stated that this ore could not be enriched economically by any known means.

"Only a few seconds were necessary for completely separating the sulphide of copper from the rest of the gangue in which no single trace of copper could be discovered by analysis.

Example 2.

"A calcitous ore having 10% of lead and unmar

ketable with such a proportion, has been treated in the same manner and with the same success. There are several operations which are distinct but which are connected in carrying the process into practice; the formation of the spherules and their separation from the gangue, then separation of the product of the concentration from the oil and recovery of this latter for readmission to the cycle of operations. The products of the concentration form cakes."

This patent discloses the following points:

(1) The preferential affinity of a "fatty substance," such as "ordinary oil," for metalliferous particles, specifically natural sulfids reduced to powder.

(2) The use of a relatively small amount of oil, for example, "a thin layer" in the test tube experiment treating 41 grams of pulp, the purpose being merely to "moisten" the sulfids.

(3) The addition of a small amount of sulfuric acid to the pulp.

(4) The agitation of the entire mixture for a brief space.

(5) The liberation of a gas in the mass and the attachment of bubbles of the gas to the oiled sulfid particles.

(6) The consequent flotation of the sulfid, rising to the top of the liquid as a distinct magma or froth.

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(7) The removal of the concentrate froth and the separation of the oil therefrom for re-use.

In the test-tube experiment, limestone, that is, calcium carbonate, is added to the ore, reacting with the sulfuric acid added to the water to produce carbon dioxid or carbonic-acid gas, this gas being evolved in the nascent state and its bubbles becoming attached to the oiled sulfid particles, or each becoming covered with an envelope of the fine sulfid particles. The patentee notes that the amount and character of the limestone should be such that the evolution of gas is not too rapid, so as to project the contents of the tube out of its top.

In "Example 1," the specified ore naturally contains carbonates, to-wit, "carbonate of iron," "dolomite" (a double carbonate) and "calcite" (calcium carbonate), which are chemically like limestone. These carbonates would also react with the acid to evolve gas and float the oiled sulfid. The apparatus used for agitating the mixture of ore, water, oil and acid, in this "Example" or in a practical operation, is not described, evidently because Froment considered that suitable agitators were well known and would be chosen by those skilled in the art. Thorough agitation is obviously necessary to distribute the small amount of oil thinly over the innumerable small particles of sulfid to be coated.

Some simple experiments which I have made in connection with this Froment patent may be of interest, as follows:

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(1) A glass test tube holding 100 cubic centimeters was half filled with water, corked and well agitated for a brief period. The air in the tube above the water was thus shaken into it and intimately distributed throughout it in the form of fine bubbles, which, however, quickly rose to the surface of the water and escaped as soon as the agitation was discontinued.

(2) The same experiment was repeated, with the difference, that one drop of "red oil," the impure oleic acid used by defendant in carrying out his process, was first added to the water. In this case, the fine bubbles of air entangled in the water upon agitation did not quickly float, but remained distributed throughout the water for a considerable period, giving it a milky appearance.

(3) Ten grams of the ore which is being treated by defendant according to his process involved in this suit, finely-powdered, was taken and placed in the empty 100 cc. test tube. This ore, from the "Black Rock" mine of the Butte & Superior Copper Company, assayed about 20 per cent. zinc, equivalent to a content of about 30 per cent. of zinc sulfid. It also contained rhodochrosite, a manganese carbonate easily decomposed by sulfuric acid to give carbon dioxid gas. Upon adding thirty cubic centimeters of water to the ore in the test tube, some of the mineral floated, by reason of the air within the mass of ore and the films of air surrounding some of the small particles.

(4) A few drops of sulfuric acid were now added to the ore and water in the test tube, and the mixture

was gently heated, whereupon gas was chemically liberated by the action of the acid on the carbonate and sulfid of the ore, evolving carbon dioxid and hydrogen sulfid, and considerable mineral rose to the surface of the liquid, floated by the adherent gas-bubbles, as in the well-known Potter and Delprat methods, heretofore referred to by me. This mineral, however, floated for a brief period only and then again subsided to the bottom of the tube.

(5) One drop of olive oil was now added to the acidulated water and ore in the test tube, and the tube was agitated for a brief space, whereupon a large mass of oiled and aerated mineral floated to the top, in the form of a magma or froth having the characteristics described in the Froment patent. It was found that agitation of the mixture for a brief period, such as was necessary to distribute the drop of oil over the innumerable particles of zinc sulfid in the ten grams of ore and moisten their surface with a film of oil, also thoroughly aerated the liquid, by the air shaken into it, just as in the experiment numbered (2) above. These fine bubbles of air throughout the mass, as well as the nascent gas chemically liberated throughout the mass, attached themselves to the oiled particles and assisted in floating them to the top as a froth.

(6) In order to oil the mineral particles without agitation, two drops of cotton-seed oil were dissolved in a few cubic centimeters of ether, and ten grams of the finely-powdered "Black Rock" ore heretofore described was moistened with the solution. The ether was al-

lowed to evaporate, leaving the oil adhering to the mineral particles as a thin film. The oiled ore was then placed in a test tube, thirty grams of water were introduced, five drops of sulfuric acid were added, and the whole was gently heated to cause the sulfuric acid to react on the carbonate in the ore. The nascent gas generated by the reaction attached itself to the oiled mineral particles and floated them to the top.

(7) Ten grams of the "Black Rock" ore were mixed, in one instance with one gram of limestone, or calcium carbonate, as prescribed by Froment, and in another instance with a half gram of rhodochrosite, the manganese carbonate occurring in the "Black Rock" ore, a thin layer or a few drops of olive oil were added, and a few drops of sulfuric acid. On warming to start the reaction, and agitating for a brief period, the oiled mineral floated as a froth.

I have heretofore stated that an agitating apparatus consisting of an open vessel in which is centrally journaled a vertical shaft having radial arms at its lower end, the shaft being rapidly revolved, such as is shown and described in the Schwarz patent 807,503, and the Kirby patents 809,959 and 838,626, constitutes an efficient means for aerating ore-pulp, or entangling atmospheric air and distributing it throughout the mass in innumerable fine bubbles, capable of attaching themselves to oiled mineral particles and floating them as froth. I have had considerable experience with apparatus of this type, both with a form of laboratory or test apparatus designed in part by the defendant, and

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called a "slide machine," and with the apparatus commercially employed by defendant, as installed by him in the mill of the Butte & Superior Copper Company, at Basin, Montana. In both the laboratory and commercial apparatus, the agitator is an open vessel in which is journaled a vertical shaft driven by a belt or gear at one end and having at its other end four radial arms or blades. I have also had built and have tested the agitator shown in the patent in suit, consisting of an open vessel in which is journaled a shaft carrying a hollow cone; and the agitator shown in Figure 1 of the Sulman & Kirkpatrick-Picard patent 793,808, consisting of an open trough near the bottom of which is journaled a perforated coiled pipe. Both the cone and the coiled pipe stir the water or ore-pulp vigorously and produce a froth, but appear not to be as efficient as the radial-arm type.

By using the Hyde slide machine, I have been able to carry out a process of separation corresponding to that of the Kirby patent 809,959. For this purpose, I took 500 grams of the finely-pulverized "Black Rock" ore which is treated by the defendant, and mixed it with from "three to five times" its weight of water, that is, with sixteen hundred cubic centimeters, acidulated by the addition of 1 cubic centimeter of sulfuric acid, and with an amount of kerosene equal to one-fourth that of the ore, that is, 125 grams. The temperature of the water used was 35° C. On agitating this mixture for thirty seconds by rotation of the central shaft having four radial arms, I was able to so

thoroughly oil the sulfid and aerate the oiled particles by the air entrained by the agitation, without any injection of streams of air to float the particles entangled in the tailings, as to produce a floating froth of concentrates nearly half an inch thick. I also roughly imitated the operation of blowing in air carried out by Kirby, by the use of a single tube pushed downward into the tailings at the bottom and moved about therein. By removing this first froth and repeating the operation of aerating by agitating, I was able to remove so much of the zinc sulfid from the ore as to leave the tailings comparatively light in color, that is, consisting largely of gangue.

Adjourned until Tuesday, May 7, 1912, at ten A. M., same place.

WASHINGTON, D. C., May 8, 1912.

Met pursuant to adjournment. Present, counsel as before.

Direct-examination of Eugene A. Byrnes continued. (Answer to Q. 4 continued.)

By the use of this same Hyde slide machine, I have also carried out the process of the Schwarz patents 807,501 and 807,503, thoroughly mixing the ore with the oil before agitating and aerating the mass to produce the froth of concentrates. For this purpose I took 500 grams of the pulverized "Black Rock" ore, assaying 20.3 zinc, added 20 cubic centimeters of cotton-seed oil and mixed the whole thoroughly with a

blade, giving a homogeneous mass having the consistency of molding sand. The slide apparatus was then filled to the normal level with 1700 cubic centimeters of water acidulated with one cubic centimeter of sulfuric acid, its temperature being 76° F. The oiled ore was added and the mixture was then agitated for thirty seconds by driving the vertical shaft with radial agitating blades. A heavy froth was produced and removed. The mass was then reagitated for the same period, another froth made and removed, and this operation repeated until six froths had been separated. These froths, combined, were filtered and dried, and their weight was found to be 230 grams. The assayer reported their contents of zinc as 41.7 per cent. The assayer to whom I refer was W. R. Hocking, manager of "The Rombauer Assay Co.," of Butte, Montana. The tailings from these operations were also removed and dried, and their weight was found to be 277 grams, containing, as reported by the assayer, 0.7 per cent. of zinc. These tailings were nearly white and it was evident to the eye that the metalliferous constituents thereof had been almost entirely removed. In this experiment, I did not inject a gaseous fluid, such as air, steam, or carbon dioxid, which Schwarz states may optionally be used, relying simply on the agitation to effect the production of a froth. The specific gravity of cotton-seed oil being about 0.9, the 20 cubic centimeters which I used in this test was about 18 grams, or 3.6 per cent. of the ore treated. The zinc being present in the ore in the form of its sulfid, a content of 20 per

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cent. of zinc, as reported, corresponds to a content of its sulfid of about 30 per cent. The 500 grams of ore therefore contained about 150 grams of the zinc sulfid, and the 18 grams of cotton-seed oil were thus 12 per cent of this metalliferous constituent of the ore.

I also carried out the operation of the Everson patent 348,157, by using the Hyde slide machine to effect the thorough agitation of the oiled ore and removal of the sand by means of acidulated water, floating off the concentrates. This Everson process is similar to that of Schwarz, in that the ore is oiled before it is agitated with acidulated water. For this purpose, I employed the materials and proportions specified in lines 75-92 of the patent, using as an acid the sulfuric acid mentioned in lines 8 and 119. I used eight times the amount specified, that is, sixteen ounces of the pulverized "Black Rock" ore, and 24 fluid drams of petroleum, in this instance having a gravity of 33° Beaume. I thoroughly mixed the ore and petroleum, producing a homogeneous mass having the consistency of damp sand. I then placed in the slide machine 1600 cubic centimeters of water, acidulated with three cubic centimeters of sulfuric acid, having a temperature of 27° C. The agitator of the machine was then started and the oiled ore gradually added. The agitation was continued for thirty seconds, producing a good froth, which was removed. The mixture was then reagitated for thirty seconds, and the second froth removed. In order to maintain the acidity of the water, to assist in cutting away the sand from the oiled materials, as de-

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scribed by Everson, one cubic centimeter of sulfuric acid was now added. The mixture was then reagitated several times and four froths removed. One cubic centimeter of sulfuric acid was again added and the mixture was successively reagitated three more times and three froths removed. The nine froths were mixed and filtered. The residual concentrates were then washed several times with gasoline to entirely remove the oil therein, and were dried and weighed. Their weight was 144 grams. The tailings were nearly white or quite light-colored, the greater amount of the zinc sulfid having been removed therefrom, as was apparent to the eye.

My tests of the apparatus which I had built in accordance with Fig. 1 of the Sulman & Kirkpatrick-Picard patent 793,808 show that it is capable of producing a very satisfactory froth of concentrates. This apparatus, which I had built to scale from the drawing of the patent, had an agitator of perforated coiled gas-pipe, three-eights of an inch in internal diameter, and about four feet long. This coil, when rapidly rotated by power produced a very vigorous agitation and stirring of the liquid in the tank or trough. I tested it without supplying compressed air to the end of the pipe, and found that while it would stir in some air from the surface of the liquid, it was not an efficient means for entangling atmospheric air, as is the Schwarz, Kirby and Hyde agitator with radial arms. When the apparatus was run on an ore-pulp consisting of warm water and pulverized "Black Rock" ore, and

compressed air carrying "red oil" was supplied to the end of the coiled pipe, the air escaping from the perforations of the pipe was thoroughly beaten through the pulp, coating the metalliferous particles with a thin film of oil and attaching bubbles of air to the oiled particles, which were thus raised to the surface by gaseous flotation, producing a thick and satisfactory froth. I skimmed off many handfuls of this thick froth and found it very heavy by reason of its high content of zinc sulfid. It was quite clear that several repetitions of the agitation and defrothing, or continued agitation and removal of the froth, would have separated a very considerable amount of the zinc sulfid from the ore, quite possibly rendering the apparatus a commercial one.

I have repeatedly operated the process of the Froment British patent 12,778 of 1902, using the Hyde slide apparatus to effect the brief agitation and frothing, and using different kinds of oil and widely-differing amounts of oil. The data of some of these Froment operations, using the finely-pulverized "Black Rock" ore having a zinc content of 20.3 per cent., are as follows:

A mixture of 492 grams of ore, 1700 cubic centimeters or grams of water, at 70° Fahrenheit, 0.3 cubic centimeters of cotton-seed oil and one cubic centimeter of sulfuric acid was agitated and defrothed five times. The fine froths were filtered and dried, giving concentrates having a weight of 170.5 grams, reported by the assayer to contain 50.0 per cent. of zinc. The tailings

weighed 315.5 grams and had a reported zinc content of 4.2.

The process was repeated under precisely the same conditions, except that 20 cubic centimeters of cotton-seed oil, or 66 times as much, was used. Six froths were made and removed, and the dried concentrates, plus some oil therein, weighed 211 grams and had a zinc content of 48.3 per cent. The tailings, plus some oil therein, weighed 292 grams and contained 1.0 per cent. of zinc.

The process was repeated under precisely the same conditions, except that 20 cubic centimeters of Ehrmann's California olive oil was used. Five froths were made and removed, the concentrates, plus some oil, weighing 219 grams and having a zinc content of 44.3 per cent. The tailings, including some oil, weighed 274 grams and contained 0.6 per cent. of zinc.

The process was repeated under the same conditions, but using 20 cubic centimeters of "red oil," impure oleic acid, from Charles T. Perry & Co., of Helena, Montana. Three froths were made, removed and dried. The weight of the concentrates was 65 grams and their reported zinc content was 42.2 per cent. The tailings were not cleaned, but showed on their surface small particles of aggregated mineral, or "flocks," perhaps half a millimeter, or one-fiftieth of an inch, average diameter.

The amount of cotton-seed, olive and "red oil" used in the last three operations was more than 3.6 per cent. of the weight of the ore, and more than 12 per cent. of the weight of the zinc sulfid in the ore.

The process was repeated under the same conditions, using 500 grams of ore, except that ten cubic centimeters of "red oil" was used. Four froths were made, removed and dried. The concentrates therein weighed 202 grams, and had a reported zinc content of 47.5 per cent. The tailings were very white, weighed 288 grams, and contained a reported zinc content of 1.1 per cent. It should be noted that the "red oil" used in this test was a special or somewhat purer form of oleic acid than that used in the preceding run, more of the solid fatty acids, stearic and palmitic, having been removed by the maker, Charles T. Perry & Co., rendering it thinner and less viscous, pasty or solid at ordinary temperatures.

I have made some tests of the apparatus shown in Figure 1 of the patent in suit, the agitator or mixing vessel and the froth-separating apparatus being made for me to scale as closely as could be determined, the cylindrical vessel containing the agitating cone having a height of 12 inches and a width of 6 inches.

In one run, this vessel was filled with water to the maximum height permissible with rapid rotation of the cone without throwing the water out of the vessel, which was found to be two-thirds of its height, or 8 inches. The amount of water then contained was 3200 cubic centimeters. To this water was added one cubic centimeter of sulfuric acid and three-fourths of a cubic centimeter of "red oil." The water was previously heated and had a temperature of 35° C. The cone mixer was now rapidly rotated and 500 grams of pul-

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verized "Black Rock" ore was introduced, the agitation being continued for ten minutes. The stop-cock in the pipe leading from the vessel to the froth-separator was then opened, and most of the mixture siphoned out. The cone being maintained in motion, wash-water was added to remove the residue, and the vessel was slightly tilted to empty out the portion contained in the concave bottom. Some froth floated down the shallow trough and over the body of the water contained in the spitzkasten, passing on into the launder and being collected and filtered. Considerable mineral, in the form of fine individual oil particles, also floated down on the surface of the water, as a mere film supported by surface tension. This was also delivered to the launder and collected with the froth, care being taken to recover all of the floating mineral, whether froth or film. I was not able to verify the statement in line 92 of page 1 of the patent in suit, that the ~~film~~ scum or mineral floated derives its power of flotation "mainly from the inclusion of air-bubbles introduced into the mass by the agitation," by reason of the film flotation of so much of the mineral distinct from the aerated froth. All of the concentrates floated and collected were dried and their total weight was 33 grams. The tailings showed hardly any perceptible change in color from the original ore, as was to be expected from the comparatively small amount of mineral removed by flotation.

I then carefully washed out all of the apparatus and made another run, with 3200 cubic centimeters of wat-

er at 35° C., 1.4 cubic centimeters of "red oil," 2 cubic centimeters of sulfuric acid and 500 grams of pulverized "Black Rock" ore. The agitation was here continued for five minutes, all of the mixture in the vessel was washed out, with agitation, and all of the mineral floating as froths or films was collected and dried. The weight of the concentrates recovered was 49 grams. The tailings were very little changed in color.

From my study of the prior art, and from my tests of the processes disclosed therein, as well as of the process in suit, I am entirely unable to find any point of novelty in the process described and claimed in the patent in suit, so far as it is carried out by the use of the apparatus shown in Figure 1. I disregard the modified apparatus of Figure 2, and the supplemental or modified processes involving solution of air in the agitated pulp by superatmospheric pressure, or distribution of the tailings in a thin layer on a shaking-table or the like, as described on page 2, line 103, to page 3, line 34, and on page 2, lines 25 to 39, these modifications constituting the subjects of separate applications referred to, which have since matured into patents.

I find a clear disclosure of the preferential affinity of oils and fats for the metalliferous constituents of ores, especially sulfids, or for graphite, in the specified prior patents to Everson, No. 348,157; Elmore, 676,679 and 689,070; Glogner, 736,381; Good, 745,960; Cattermole, 777,273; Cattermole, Sulman & Kirkpatrick-Picard, Nos. 777,274 and 788,247; Sulman &

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Kirkpatrick-Picard, No. 793,808; Schwarz, 807,501 and 807,503; Kirby, 809,959 and 838,626; and Froment British, 12,778 of 1902.

I find a clear disclosure of the use of acid, for example, sulfuric acid, including small amounts of acid, in processes of oiling the metalliferous constituents of ore, with statements that acid increases the preferential affinity of oil for the metalliferous constituent, in the specified patents to Everson; Elmore, No. 689,070, which claims this feature, *i. e.*, the enhancement of the selective action of oil by the use of very small quantities of acid, instancing sulfuric and oleic acids, added to the ore-pulp or oil, the quantity being varied, however, to produce the best results; Cattermole, No. 777,-273, acknowledged in the patent in suit, specifying a fraction of one per cent. and mentioning sulfuric acid; Cattermole, Sulman & Kirkpatrick-Picard, No. 777,-274, also acknowledged in the patent in suit, and No. 788,247, the description of which is identical as to the mode of oiling, and which states that any slight excess of acid beyond that acting to decompose the soap solution used as a source of the oiling agent will react on carbonates or easily-decomposible sulfids in the ore to generate gas; Sulman & Kirkpatrick-Picard, No. 793,-808; Schwarz, 807,503; Kirby, 809,959, which particularly notes that the preferential action may be regulated by the addition of acid; and Froment, 12,778 of 1902.

The flotation of oiled mineral particles by the attachment thereto of films or bubbles of air, or gas, or,

otherwise stated, by the adhesion of the oiled particles to bubbles of air or gas, is clearly disclosed in the Cattermole, Sulman & Kirkpatrick-Picard patent 788,247; in Sulman & Kirkpatrick-Picard, 793,808; Schwarz, 807,501 and 807,503; Kirby, 809,959 and 838,626; and Froment, 12,778 of 1902. And the use of agitators which, as shown by my tests, will aerate a mixture of oil and acidulated ore-pulp by entangling atmospheric air and beating it through the mixture in the form of fine bubbles, attaching themselves to the oiled mineral particles, is described in Everson; Cattermole, 777,273; Cattermole, Sulman & Kirkpatrick-Picard, 777,274; Schwarz, 807,501 and 807,503, the latter illustrating and describing defendant's agitating device, a vertical shaft with agitating blades; and Kirby, 809,959 and 838,626, also illustrating defendant's stirrer with radial blades. Glogner, 736,381, illustrates an oscillating agitating vessel, in which the mixture of ore-pulp and water is thrown violently against one end of the vessel, the wave falling back through the air, thus imitating the aeration and frothing produced by an ocean wave. Froment, as I have noted, confines his description to the process and its principles, leaving the type of agitator to be determined by the user. In his test-tube experiment, agitation sufficient to coat the mineral particles with a thin film of the oiling agent also thoroughly aerates the mixture, the fine bubbles of air distributed throughout it, and attaching themselves to the oiled particles, acting with the chemically-evolved gas to float them. The function of the gas-bubbles

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is identical, whether they be of atmospheric air shaken or beaten into the mixture; air or gas injected in streams; gas chemically evolved throughout the mixture; gas electrolytically evolved by decomposition of the liquid; gas liberated by first increasing the amount in solution in the liquid by the use of pressure and then releasing the pressure; all described in the patents referred to by me; air or gas normally in solution in the liquid and evolved by creating a partial vacuum over its surface; or gas produced by boiling the liquid, as described in patent No. 835,143 to Henry L. Sulman. Another patent to Sulman, Kirkpatrick-Picard & Ballot, No. 835,479, refers to the fact that several methods are known for producing the gaseous films or bubbles used to float the particles.

The fact that oils and fatty acids in general have a preferential affinity for metalliferous matter and graphite is recognized by the patent in suit. The particular oiling agent described, oleic acid, and its liberation *in situ* in the pulp by the decomposition of a soap solution, are disclaimed in the patent in suit as described in the Cattermole patent No. 777,274.

The fact that widely different amounts of the same oiling agent, indiscriminately over as well as under one per cent. or a fraction of one per cent. of the weight of the ore, may be successfully used to oil the mineral and float it by attached gas films or bubbles is shown by the prior patents referred to by me, and by the practical tests which I have made and described. It is also to be noted that the limitation of some of the

claims of the patent in suit to a proportion of the oiling agent amounting to a fraction of one per cent. on the ore, does not exclude the proportions specified in the Cattermole patent No. 777,273, in which the percentage of oil is based on the weight of the metalliferous mineral in the ore, and the usual range is stated to be from 4 to 6 per cent. of oil by this weight of mineral.

The use of warm water, or a warm mixture, having a temperature of say 30 to 40° C., as described in the patent in suit, is an obvious and necessary expedient when oleic acid is the oiling agent, since this acid is solid at all lower atmospheric temperatures, and must be heated to a temperature at which it is thinly liquid, to enable it to be distributed throughout the ore as a minute film covering the metalliferous particles. Oleic acid is one of the constituents of and is ordinarily derived from animal fats, such as tallow. Its behavior may be understood by referring to the analogy of butter. Iced butter is solid, non-plastic and difficult to spread. At lower and moderate atmospheric temperatures, it is plastic and may readily be spread. If we wish to distribute butter as a thin film over the surface of small grains, for example popcorn, we slightly raise its temperature until it is thinly liquid. I have made some rough tests of the impure oleic acid used by defendant in his flotation plant at the Basin, Montana, mill of the Butte & Superior Copper Company, and which was also used by me in all of my tests, except the one in which, with the slide machine, I used ten

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cubic centimeters of a special thin oleic acid, as stated. For this purpose, I unscrewed the plug in the side of one of the iron drums in which this oil is received at Basin. This drum had been lying in the sun outside the mill for some time. I found that the "red oil" in the drum was entirely solid, and on pushing a thermometer down into it 12 inches found that its temperature at the center of the drum was 7° C. With a stick I took out some of the solid oil, about 400 cubic centimeters, placed it in a beaker and warmed it on an electric hot-plate in the laboratory. When a small portion of the oil had become liquefied, I removed the beaker from the plate and let it stand for a few minutes. The temperature of the liquid portion was then 18° C. I then returned it to the hot-plate and continued the heating until all the grains of solid fat suspended in the liquid had become melted. The temperature of complete fluidity, with thorough stirring, after removal from the hot-plate, was about 38° C. As the temperature of the ore-pulp supplied to the Hyde flotation apparatus at the Basin plant was normally very low, far below the solidification point of "red oil," it was, of course, necessary to warm the pulp in the agitator in order to keep the oil liquid and enable it to coat the zinc sulfid particles. The flume supplying this mill with water, on different days when I examined it, was coated with ice, although the weather in April was bright and sunny. The temperature of the water in this flume, as tested by me at different times, was only 1 or 2 degrees above freezing. And

the temperature of the ore-pulp delivered at the bottom of the mill to the elevator carrying it to the Hyde flotation plant was found by me to be 3° C. I took a quart of this pulp in a thin vessel, carried it up to the flotation plant and allowed some of the oil feeding to the first agitator to drop upon its surface, whereon it solidified at once.

The heating of the oil, or mixture of pulp and oil, or its maintenance at a proper temperature to keep the oil liquid and effect the oiling of the metalliferous particles with a thin film, is described in the specified Everson patent; in Sulman & Kirkpatrick-Picard 793,-808; in Schwarz 807,501 and 807,503; and in Kirby 809,959.

The patent in suit is very vague as to the details of the process and as to the proportions of oil and acid to be employed, indicating that preliminary tests are necessary with different ores to determine the proper amount. Although an "example" of the application of the process to a particular ore is described, the proportion of oleic acid to be added to effect the oiling is specified as "say from 0.02 per cent. to 0.5 per cent. on the weight of the ore," leaving it to the user to determine whether he should use the smaller proportion, the larger one, twenty-five times as much, or some intermediate one. Later, the description states, in the most general terms, that the proportion may be "under 0.1 per cent. of the ore." So again, the amount of sulfuric acid or other acid or salt to be added may be any fraction of 1 per cent. or up to 1 per cent. The particular

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"different oily substances" which are suitable "with different ores" are not described, nor any characteristics which enable the user to determine the proper one. The agitator or mixing vessel shown is confessedly old with Cattermole, and is relatively inefficient. The spitzkasten froth-separating apparatus is a very old device, and is shown in the prior art cited by me. It is therefore my opinion that this patent in suit describes and claims no new process, and employs no new principles or apparatus, except for the subject-matter expressly disclaimed as that of other applications then pending but since patented.

By Mr. Williams: Notice is given of a motion to strike out as incompetent all parts of the above answer of the witness referring to patents not pleaded by the defendant; to strike out as irrelevant all descriptions of tests alleged to be of the processes of prior patents not carried out with the procedure or in apparatus such as are disclosed in such patents. It is consented, however, that the defendant may amend his answer to include therein such patents above referred to as may not have been pleaded, subject to the usual condition that should he prevail upon any of these patents he may not recover costs for any proceedings prior to the deposition of the present witness.

Adjourned until Thursday, May 9, 1912, at 10 A. M., same place.

Deposition of Eugene A. Byrnes.

WASHINGTON, D. C., May 9, 1912.

Met pursuant to adjournment. Present, counsel as before.

Direct examination of Eugene A. Byrnes conitnued.

BY MR. WILLIAMS: It is noted that the experiments above described by the witness, not having been made in the presence of opposing parties, the observations and conclusions of the witness are objected to as not the best evidence, unless an opportunity is afforded to complainants to repeat these experiments, and the apparatus used in these experiments are offered in evidence.

It is noted that of the patents above referred to by the witness, the following patents were issued subsequently to the application for the patent in suit and are therefore not prior patents, even in the present state of the proofs: Sulman & Picard 793,808, Schwarz 807,501, Schwarz 807,503, Kirby 809,959, Sulman, Picard & Ballot 835,143, Sulman, Picard & Ballot 835,479, Kirby 838,626.

Q. 5. Do you know of any instance in the art of separating minerals, other than those cases to which you have referred, in which a liquid carrying minerals is aerated for the purpose of assisting in the separation? If so, please describe such matters as you have knowledge of.

A. It is common practice in the art of treating min-

erals by the cyanid process to thoroughly aerate the ore-pulp, by a variety of methods, for example by injecting streams of air; by flowing the pulp over an aerating surface, in a thin sheet, in contact with atmospheric air, or by beating air into the pulp by an agitator. An agitating apparatus for this purpose employing an open tank, in which is journaled a vertical shaft carrying four radial blades at its lower end is shown, for example, in U. S. patent 729,805, granted June 2, 1903, John and Leo Stoveken, in Figs. 2 and 3. I quote from this patent as follows:

> "Q Q, agitation-tanks, of which six are preferably employed, said tanks being arranged one below the other and being provided with discharge-conduits R, so as to enable the mixed solution and comminuted ore to flow by gravity from the tank nearest the pulverizer H to the next lower tank, and so on until they reach the last tank—*i. e.*, the lowest tank and that farthest from the pulverizer. . . ."
>
> "In the practical operation of our apparatus it will be observed that the solution is in contact with the ore incident to the grinding of the ore by the rolls E and F and incident to the reduction of the ore to a finely divided or comminuted state in the pulverizer H. By virtue of this and the subsequent violent agitation of the comminuted ore and solution in the tanks Q the solution reaches all of the values no matter how small the particles of ore in which the same are contained, . . ."

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"agitating-blades connected together and to the head *h* and curved in the direction of their length and inclined in the direction of their width, Figs. 2 and 3, whereby they are adapted to throw the comminuted ore and solution outward after the manner of a centrifugal pump and upward like a plow; *j j*, stationary wings connected to the side-wall of the tank and having for their purpose to force the mixture of comminuted ore and solution back to the center of the tank when the same is thrown outwardly by the blades *i*, and *k* a pipe let into the cylinder *a* below the piston *c* and designed, in common with pipes *k* of the other cylinders Q, to be connected with a source of fluid-pressure supply. When the shaft *e* is rotated by a driving connection intermeshed with the miter-gear *g*, it will be observed that the material in the tank will be thrown outwardly and upwardly against the wings *j*, which will roll it back into the center of the tank. This is materially advantageous, since in addition to being kept in suspension the material is worked up and down, and consequently the cyanid solution is caused to absorb the necessary oxygen and effect a rapid and complete dissolution of the gold and silver contained in the ore. . . ."

The stationary wings *j* are an important feature to produce thorough aeration by agitation in a cylindrical open vessel, since they prevent the rotation of the pulp as a mass, substantially at the same speed as the radial

arms. The same result is produced in the apparatus used by the defendant by the use of a square tank. The agitator of the patent in suit is defective as an aerating machine, as I noted in operating it, by reason of the specified rotation of the entire body of pulp within the smooth cylindrical vessel.

> BY MR. WILLIAMS: Notice is given of motion to strike out the above answer as incompetent, for the reason that the patent referred to has not been pleaded, subject to the consent stated in the objection to Q. 4.

Q. 6. Will you state how you find that the patentees of the patent in suit define the extent of the agitation to which they refer in the patent, stating also whether you find anything novel in agitation of such a character?

A. In the specific "example" of the application of the process given on page 1, lines 70-101, of the patent in suit, the statement as to agitation is as follows:

> ". . . The mixture is warmed, say, to 30° to 40° centrigrade and is briskly agitated in a cone mixer or the like, as in the processes previously cited, for about two and one-half to ten minutes, until the oleic acid has been brought into efficient contact with all the mineral particles in the pulp. . . ."

All processes dependent on the oiling of the mineral particles in the pulp require that the oil be brought into efficient contact with these particles. While this result

can be effected without agitation, by dissolving the oil in ether and saturating the dry ore with the solution, in practice, and in the various oil-gas flotation processes set forth in the prior art referred to by me, the oiling is effected by mechanical agitation, which would obviously be continued until the mineral particles had been brought into contact with the oil and coated therewith.

Q. 7. What significance, if any, do you attach to the word "mainly" as used in line 92, page 1, of the patent in suit?

A. The statement that the flotative power of the froth or scum is derived "mainly from the inclusion of air-bubbles introduced into the mass by the agitation" is a recognition of the fact that in the process of this patent some of the mineral is floated without included air-bubbles, that is, as individual oiled particles, floating as a film by reason of surface-tension. As stated in my answer to Q. 5, in my operation of an apparatus constructed in accordance with Fig. 1 of the drawing of this patent, I found that a considerable portion of the mineral was so floated as a film and not as a froth.

Q. 8. Assuming the practice of a process of the general character set forth in the patent in suit, using an amount of acid insufficient to cause chemical action on the metalliferous minerals present, do you know of any advantage which would result from the use of such an amount of acid, other than some slight economy possibly resulting from the reduction of the quantity of acid to the point specified?

A. Assuming, without intending to admit, that an

acid capable of reacting on the metalliferous minerals would not so react if used in small proportion, I see no advantage to be derived from the use of such small proportion, except the saving in the cost. Acid capable of reacting on constituents of the ore to produce a gas has the double function of increasing the preferential affinity of the oil for the mineral, which requires an amount not definitely specified in the patent in suit, and which doubtless varies with different ores; and of assisting in the flotation by the production of bubbles of gas, evolved in a nascent state, and in minute and extended subdivision throughout the body of pulp, wherever the acid comes in contact with a gas-generating particle of ore.

Q. 9. In the patent in suit I find frequent use of the expression "powdered ore." Will you explain the meaning of this expression, both as used in common parlance and whether it would have any different meaning in connection with a metallurgical operation?

A. "Powdered ore" is ore which has been converted into a powder, as by crushing, grinding or passing between rolls. I do not apprehend that the term is used with any other or unusual significance in the patent in suit. The patentees speak of crushing the ore "to ninety mesh to the linear inch, (half of which ore will pass through one-hundred and fifty mesh sieve,)"; also that "Crushed ore is fed from a hopper C into the vessel (A) by a band B." "Crushed ore or similar finely-divided mineral is fed into the vessel *a*." In other words, the dry powder of ore, which may be crushed to the

can be effected without agitation, by dissolving the oil in ether and saturating the dry ore with the solution, in practice, and in the various oil-gas flotation processes set forth in the prior art referred to by me, the oiling is effected by mechanical agitation, which would obviously be continued until the mineral particles had been brought into contact with the oil and coated therewith.

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acid capable of reacting on the metalliferous minerals would not so react if used in small proportion, I see no advantage to be derived from the use of such small proportion, except the saving in the cost. Acid capable of reacting on constituents of the ore to produce a gas has the double function of increasing the preferential affinity of the oil for the mineral, which requires an amount not definitely specified in the patent in suit, and which doubtless varies with different ores; and of assisting in the flotation by the production of bubbles of gas, evolved in a nascent state, and in minute and extended subdivision throughout the body of pulp, wherever the acid comes in contact with a gas-generating particle of ore.

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A. "Powdered ore" is ore which has been converted into a powder, as by crushing, grinding or passing between rolls. I do not apprehend that the term is used with any other or unusual significance in the patent in suit. The patentees speak of crushing the ore "to ninety mesh to the linear inch, (half of which ore will pass through one-hundred and fifty mesh sieve,)"; also that "Crushed ore is fed from a hopper C into the vessel (A) by a band B." "Crushed ore or similar finely-divided mineral is fed into the vessel *a*." In other words, the dry powder of ore, which may be crushed to the

size specified, is delivered into the mixing vessel A or *a*. The band "B" shown in Figure 1 is adapted to convey such dry powdered ore from hopper C into vessel A.

Q. 10. Would the band B to which you have referred be adapted, in your opinion, to convey a freely-flowing pulp from the hopper C to the vessel A?

A. No, it would be entirely unsuited for such purpose, since the pulp would then flow off from the belt in all directions, rearwardly and laterally as well as toward the vessel A.

Q. 11. Do you find anything in the patent in suit that would guide one as to the amount of oil and acid to be used further than or more definite than the directions set forth in the Froment British patent to which you have referred?

A. I do not. The patent in suit states that a preliminary test is necessary with any particular ore, to determine the oily substance to be used, and in the specific "example" simply specifies "a very small proportion of oleic acid (say, from 0.02 per cent. to 0.5 per cent. on the weight of ore), a very wide range, with no statement or indication as to whether the 0.02 per cent. is preferable or the higher limit, twenty-five times as much, or what conditions are to determine the amount to be used. In the Froment patent 12,788 of 1902, it is stated that the sulfids reduced to powder are to be "moistened" by the fatty substance, indicating that a sufficient amount should be used to coat the surface of the particles with a film. In the test tube

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example, for a charge consisting of 41 grams, a "thin layer" of oil is specified.

As to the acid, while the patent in suit disclaims any intention to have the acid act on the ore and generate gas, but signifies that it is used simply to increase the preferential affinity of the oil for the mineral, it is stated that any indefinite amount up to, *e. g.*, 1 per cent. of sulfuric acid by weight of the water may be used. Whether 1 per cent. or one-hundredth of 1 per cent. is preferable is not stated, nor is any information given to enable the user to determine which proportion should be adopted, or what conditions control the amount. Here, also, as with the oil, the amount must evidently be determined by experiments or preliminary tests with the particular ore to be treated. One per cent. of sulfuric acid on the weight of the water which I used in operating the process of this patent in suit, being 3200 grams of water, would be 32 grams, for 500 grams of ore treated, an amount sufficient to decompose over 37.5 grams of rhodochrosite, the manganese carbonate present in the ore, or about 7.5 per cent. of its weight of this mineral, which is entirely decomposed by sulfuric acid with the evolution of carbon dioxid. The Froment patent states that for a pulp consisting of 10 grams of sulfid ore, one gram of limestone or calcium carbonate, and ~~50~~ 32 grams of water, "a few drops of sulfuric acid" are suitable.

Q. 12. In your opinion, would the apparatus shown in Fig. 1 of the drawing of Sulman & Picard patent 793,808, be operative to accomplish the desired result

without vigorous rotation of the finely coiled perforated pipe B^1?

A. It would not. I tested the apparatus which I had built in accordance with Figure 1 of this patent by supplying compressed air to the coiled pipe without rotating it, and found that the air simply streamed upward in lines of bubbles from the numerous perforations in the pipe, without thoroughly aerating or frothing the liquid. Upon rotating the coiled pipe, however, the vigorous agitation produced by its several turns forcibly displacing the liquid caused the issuing air to be thoroughly beaten into the pulp, aerating it and producing a froth carrying the oiled mineral.

Q. 13. Would it be possible to efficiently oil the mineral particles by means of said apparatus without vigorous rotation of the coiled pipe?

A. It would not, since the oil is introduced by the current of compressed air, being carried thereby as a fine spray or vapor. Without rotation of the coil, the oil would simply rise to the surface with the air issuing from the stationary perforations of the pipe. The same rotation and beating action is necessary to bring the oil into contact with the mineral particles, as to aerate them.

Q. 14. Would there, in your opinion, be any difference in the action of carbon dioxid produced by the action of acid upon a carbonate forming part of an ore and its action upon some carbonate added to the ore in a process of the character described in the patent in suit and in the Froment British patent and other patents to which you have referred?

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A. The carbonate would react in the same way, and the same amount would evolve the same amount of gas, whether it was naturally present in the ore and was exposed to the acid by powdering the ore, or was added to the ore as a powder. This fact is recognized by Sulman & Kirkpatrick-Picard, two of the grantees of the patent in suit, in patent 788,247, granted jointly to them and A. E. Cattermole, in which they state that—

> "If the ore contains a carbonate, any small excess of the acid used to decompose the soap or similar alkaline compound will also liberate bubbles of carbonic acid, which will attach themselves to the fatty acid-coated mineral particles and float them to the surface, or a suitable carbonate (or other substance capable of liberating a gas on the addition of a suitable acid, such as an easily decomposable sulfid, etc.) may be initially added to the ore mass for such purpose."

The Froment patent, No. 12,778, of 1902, also gives two examples, in one of which a carbonate is added to the ore to evolve gas with the sulfuric acid, and in the other of which the ore naturally contains carbonates. "Limestone," specified as added to the ore in the first example, is "calcite," specified as present in the ore of the second example.

Q. 15. I hand you a certified copy of the application for and proceedings leading to the grant of Cattermole, Sulman & Kirkpatrick-Picard patent No. 788,247, and

ask your opinion as to the relation between the quantity of oleic acid which the applicants state they use, as indicated in the expression that they "only seek to coat every particle of metalliferous matter as thinly and evenly as possible," and the quantity of oleic acid specified in the patent in suit? The expression above quoted occurs in an argument filed by the applicants for said patent December 31, 1904, the paper in question being designated "Paper No. 4."

By Mr. Scott: The papers referred to in the preceding question are introduced in evidence and marked by the Notary "Defendant's Exhibit Certified Copy of File-Wrapper and Contents of Patent 788,247."

By Mr. Williams: It is noted that statements made in the prosecution of another application for its patent than the patent in suit appear to be irrelevant to the issues herein, and the exhibit and the question are therefore objected to as irrelevant as well as incompetent.

A. As I noted in my answer to Q. 4, this application Ser. No. 200,649 was filed simultaneously with another application by the same parties, No. 200,650, which latter matured into patent 777,274, acknowledged in the patent in suit; and the description of the method of oiling the mineral by a fatty acid, etc., liberated from a soap solution added to the pulp is almost identical in both, lines 10-56 of page 1 of 777,274 being nearly the same as lines 9-53 of page 1 of 788,247.

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The only differences which I find between the two in this respect are the interchange of the serial numbers, in the cross-references in each application to the other; the use of the word "wetted" in line 47 of 788,247, instead of "wet" in line 48 of 777,274; and the clause, "The mineral particles now attached to or more or less coated or inclosed by films of fatty or resin acids," in lines 53-55 of 788,247, instead of "and the mineral particles become attached to or more or less coated by films of fatty or resin acid," in lines 54-6 of 777,274. The descriptions of both specify the addition to the ore-pulp of "a small quantity of soap solution" and a "small amount of mineral acid" to decompose the soap and liberate the fatty or resin acid which is the oiling agent. The specified purpose in both is that the "mineral particles" shall become "attached to or more or less coated (or inclosed) by films of fatty or resin acid (acids)." That is, no distinction is made between the amount of soap and mineral acid to be used, and the amount of fatty or resin acid to be set free therefrom and used to coat the mineral particles with a film, whether the coated particles are to be caused to adhere and form granules, as in the specific separation method of 777,274, or are to be floated by gas bubbles, the specific process of 788,247. The statement quoted in the question from the file-record of 788,247, that applicants "only seek to coat every particle of metalliferous matter as thinly and evenly as possible" with the oleic acid liberated from the soap solution, would therefore apparently apply with equal force to the oiling process of 777,274.

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I should say, therefore, that the statement in the patent in suit, referring to patent 777,274—

> "We have found that if the proportion of oily substance be considerably reduced—say to a fraction of one per cent. on the ore—granulation ceases to take place"

was based on a misapprehension or error as to the proportion of oil actually contemplated in patent 777,274, or its complement, 788,247. In other words, I should say that patents 777,274, 788,247, and the patent in suit all describe processes of separation based on the initial oiling of the mineral particles with a bare film. As I undertsand the process of the patent in suit, it also seeks to initially "coat every particle of metalliferous matter as thinly and evenly as possible" with the oiling agent, and the proportion of oily substance must be sufficient to do this, being specified in the patent in suit as a "fraction of one per cent. on the ore." This is an amount which, as I have heretofore stated, overlaps or includes the amount of oil specified in the Cattermole patent No. 777,273, to-wit, "four per cent. to six per cent. of the weight of metalliferous mineral present in the ore."

Q. 16. Have you visited the Black Rock Mine of the Butte & Superior Copper Company, and the flotation plant which operates upon part of the ore from that mine; if so, will you kindly describe the ore which occurs in that mine, the operation of the flotation plant as you observed it, and any experiments which you performed in connection therewith?

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By Mr. Williams: Objection is made to any description of the operation of any flotation plant as called for by the question as secondary and incompetent, this objection being based upon the assumption that the plant referred to is not the experimental plant which is said to have been destroyed.

By Mr. Scott: All of the question after the first sentence is withdrawn.

A. Yes.

Q. 17. Did you observe whether any carbonates are present in that ore and the extent of their distribution in the ore; if so, please state what carbonates and to what extent they are distributed through the ore?

A. I thoroughly examined different portions of this Black Rock Mine ore, walking many hundreds of feet through the different levels. I noted that the ore is quite variable in different sections, both as to its content of blende and the character of the gangue rock. I found throughout the mine, in the various portions which I visited, that the manganese carbonate, rhodochrosite, is prevalent. This carbonate, which is readily recognizable, having a pinkish color, occurs in many places in large veins and masses, sometimes several feet in width. In many instances, a mass of well crystallized bright pink rhodochrosite occurs in a body of the richest blende ore. I took a great many specimens of the ore from different parts of the mine, including pieces rich in blende and rhodochrosite, and

large blocks of the latter alone. One day while at the mill at Basin, I walked over and carefully examined the ore in all of the steel railway cars on the siding whence it is elevated to the mill, and I found the rhodochrosite distributed throughout all of it, as I should have anticipated from my examination of the mine. I also took many samples of the ore carrying blende and rhodochrosite from these various cars. I had all of the samples taken by me, both from the mine and from these cars, shipped to my laboratory in this city, where I have since examined them. I talked with the assayer, Mr. W. R. Hocking, of Butte, Montana, who continually tests all of the Black Rock ore milled by the Butte & Superior Copper Company at Basin, as to the prevalence of rhodochrosite in the ore, and he stated that it occurred in every sample. I also talked with the assayer at the mill at Basin, and he stated that he sometimes made as many as sixty or seventy analyses of the Black Rock ore per day and invariably found the samples to contain the rhodochrosite.

By Mr. Williams: Notice is given of motion to strike out all parts of the above answer, repeating statements made by assayers, as hearsay and incompetent.

Q. 18. Have you ever performed any experiments with a full-sized flotation plant for separating minerals with a view to determining the conditions as to the quantity of oily matter, quantity of acid, and other conditions necessary to the successful operation of a

flotation process of the character conducted in the experimental machine at Basin, Montana, described by Mr. James M. Hyde and Mr. Jesse C. Gibson, in their testimony given in this suit, with which testimony, I understand, you are familiar?

A. Yes.

Q. 19. Please describe the experiments and observations which you have made.

> By Mr. Williams: The objections which were noted to the testimony of Jesse C. Gibson, taken at Butte, Montana, and first generally stated after the answer to Q. 15, and then repeated after Q. 19, are here repeated. It is submitted that a defendant may not retain a machine in secrecy, and refuse the reasonable demands for inspection thereof by opposing counsel, and nevertheless ask the court to pass upon questions involving the processes carried on in such machine, for the purpose of relieving the defendant from a charge of infringeemnt.

A. I spent a number of days at the Basin, Montana, mill of the Butte & Superior Copper Company, the first day being Monday, April 8, 1912, and the last one Sunday, April 14, 1912. During this period I thoroughly examined the entire mill, from the bins where the ore is delivered to the crusher to the final Callow cones, which produce the thickened ore-pulp delivered to the Hyde flotation plant. This flotation apparatus itself, which is a distinct department of the mill, I saw oper-

ated, and myself operated, under different conditions, on different days.

The Hyde apparatus consists of two duplicate or identical portions, arranged along opposite sides of an intermediate platform or alley. One of these portions is used to produce a diluted froth containing as much of the zinc sulfid as can be floated, which as I recall may be upwards of 90 per cent. of the ore-content, and is colloquially termed the "rougher." The other duplicate portion is used to thicken the concentrate froths delivered by the rougher, and is termed the "cleaner." By reason of the identity of these two portions or sections of the plant, their functions may be interchanged, *i. e.*, either side maybe used as the "rougher" and the other as the "cleaner." Each duplicate section of the apparatus, extending as stated along one side of the intermediate alley, consists of three units, which are termed "cells," comprising one or more agitator vessels and a flotation box. The first "cell" has three agitator vessels, arranged side by side, and communicating at their lower ends, the first receiving the thickened ore-pulp elevated from the Callow cones, and the last delivering the oiled and aerated pulp to a flotation box. Each agitator vessel is a square wooden box, within which depends a centrally revoluble shaft carrying at its lower end four radial stirring-arms. The ore-pulp fed into the first agitator vessel, initially having a temperature of about 3 degrees above the freezing point of water, during the time I was at the plant, is warmed to a temperature sufficient to keep the oiling

agent fluid and thin, by the injection of steam. The oiling agent, being the "red oil," or impure oleic acid, received in iron drums from Charles T. Perry & Co. of Helena, Montana, is melted out of the drums by rolling them onto a set of steam-coils and by injecting live steam into the drums. The liquid oil is then poured into an iron tank, itself steam-heated, located at the side of but on a higher level than the first agitator vessel. This tank has an outlet leading from its bottom and delivering into the vessel the rate of feed being regulated by a stop-cock in the outlet pipe. The pulp is warmed, oiled and agitated in the first vessel, thence delivered into the second vessel and further agitated, thence into the third vessel and agitated, and is thence delivered through an iron pipe into the side of the flotation-box, which in use is filled with water. The level of the water in this box can be regulated by a valve and is kept at such height that a thin layer of water at the top, together with the froth of concentrates floating thereon, is contiuously delivered over the transverse skimming lip extending across the front end of the box, whence the water and froth fall into a launder.

Adjourned until Friday, May 10, 1912, at 10 A. M., same place.

Deposition of Eugene A. Byrnes.

WASHINGTON, D. C., May 10, 1912.

Met pursuant to adjournment. Present, counsel as before.

Direct examination of Eugene A. Byrnes continued.

The pulp minus the first froth is continuously withdrawn from the lower end of the flotation-box to the second "cell" of the "rougher," which is identical with the first cell, except that it employs but two agitator vessels, delivering to a second flotation-box. A second froth is taken off from the second box and delivered to the same launder as the first froth, and the subsiding pulp minus the two froths is lifted and delivered into the single agitator vessel of the third "cell." A final froth is then removed from the (third) flotation-box of this cell, and is delivered into the same launder. The three froths are delivered by the launder to the "cleaner" portion of the plant, which, as stated, is a duplicate of the "rougher." And the water and tailings from the third flotation-box of the "rougher" are discharged as waste. The color of the tailings in this waste gives a very accurate idea of the amount of the metalliferous constituent, blende, which has been removed from the ore. If the "rougher" is operating properly, and the proper amounts of oil and acid are being supplied to the pulp, these tailings are almost white, whereas the original pulp is quite gray, by reason of the blende content. If the oil is fed in excess, it appears in the tailings, associated with par-

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ticles of blende, which I should hardly call "granules" on account of their small size, although doubtless several oiled particles adhere together to form the small specks or flocks which I observed when the pulp was overoiled. Excess feed of oil is also at once shown by the character of the froths rising on the flotation-boxes, which then become thinner, less heavy and viscous, and present a shiny, oily appearance, with fewer and larger entangled air-bubbles, instead of innumerable fine bubbles. In the regular operation of the plant, there is no measurement, nor is there any means for measurement, of the amount of oil and acid supplied to the pulp, the feed of both being regulated from time to time to give the best results in the production of heavy froths and clean tailings. The acid, a 25 per cent. solution of sulfuric acid, is fed into the ore-pulp before it is delivered to the "rougher."

The "cleaner" receives the three froths from the "rougher," fed into the first of the three agitator vessels of its first "cell." After successive agitation in these three vessels, the froths, including the water which was discharged with each of them from the rougher cells, is delivered into the corresponding flotation-box, where a very heavy froth, several inches in thickness rises, and is discharged over the skimming-lip, without any accompanying layer of water. The subsiding liquid is delivered from the bottom of the flotation-box to the first of the two agitators of the second cell, a second froth is taken off in its flotation-box, and the tailings are finally re-agitated and de-

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frothed in the third cell, the tailings from the third flotation-box of the "cleaner" being then elevated and returned to the first agitator of the second cell of the "rougher."

On my first visit to the plant, I observed the temperatures of the pulp in the three flotation-boxes of the "rougher," inserting a chemical thermometer through the froth in each and downward about one foot into the liquid. The temperature in the first box was 28° C., and in the second and third 27° C., each. I also took the temperatures in the three flotation-boxes of the "cleaner" and found them to be, respectively, 27.5°, 28° and 29° C. Later, at my request, the supply of steam to heat the entering ore-pulp was decreased, so that for a period of about half an hour the temperature in the three "rougher" boxes was 22° C., within a fraction of a degree in each. The froths still remained fairly heavy, and the tailings from the third box light-colored, but containing considerable mineral.

I then had the temperature raised by a supply of more steam, so that the temperature in each box was 24° C., within a fraction. The froths were then quite or fairly heavy, and the tailings quite or fairly clean, though not as good as when the temperature was 27 or 28°. These results were to be expected on account of the fact that the "red oil" used becomes thick and viscous at lower temperatures.

On another day, the "rougher" was entirely emptied, both agitators and flotation-boxes. Operations were then resumed, the pulp entering the first agitator at a

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temperature of but 3° above freezing, before the steam was admitted. The pulp was then heated until its temperature in the first flotation-box was 30° C., and about the same in the other two. For the purpose of experiment, I had the iron vessel supplying "red oil" to the first agitator emptied, before beginning this run, and supplied it with cotton-seed oil, not heated. I then ran this oil into the agitator at about three times the rate of feed which was customary with the "red oil," obtaining good froths. The tailings were also quite good, though containing some mineral. I then opened the valve in the oil-discharge pipe to its full capacity, allowing about seven times the normal feed of oil to flow, also separately adding to the agitator a few per cent. proportionate to the cotton-seed oil, of the "red oil," warmed to make it liquid. I then obtained very good heavy froths and very clean tailings, as good, I think, as I saw produced at any time when I was at the mill. It is thus apparent that different oils can be used, in widely different proportions, as I also found in my tests with the Hyde slide apparatus.

Q. 20. Have you any means of stating how long the pulp was agitated in the operations which you conducted and saw conducted at the plant at Basin with the full-sized plant with which you experimented?

BY MR. WILLIAMS: Same objection.

A. No, there was no way of determining this. The whole operation is conducted entirely by judgment, that is, by observation of the results obtained, it being

necessary to constantly vary conditions to suit the varying amount and character of the ore-pulp received. The operation is continuous, pulp being elevated from the Callow cones, in which the slime-water from the mill proper is thickened, and the froths and tailings being continuously discharged. The levels in the various flotation-boxes require constant adjustment to suit the varying feed, one or two operators being constantly employed for this purpose. The agitation was simply continued until the production of froths was satisfactory.

Q. 21. In the spitzkasten with which you experimented in the full-size plant, did you utilize any upcast or upcurrent of water?

> By Mr. Williams: Same objection, and it is stipulated that this objection will be continued, without repetition, to all further questions along this line.

A. No. No up-current or other water is supplied to the flotation-boxes, except that contained in the pulp fed into them.

Q. 22. How do carbonates compare with other mineral compounds in stability under the action of acids?

A. Mineral carbonates, for example limestone and rhodochrosite, decompose with extreme facility when reacted upon by mineral acids, such as sulfuric, carbonic acid being a very weak acid.

Q. 23. Do you know of any oil-gas flotation process for the separation of minerals ever having been com-

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mercially operated in this country, other than the operations of Mr. Hyde?

A. I do not.

Q. 24. I ask your attention to the testimony given in this suit by Edward H. Nutter, James M. Hyde, Jesse C. Gibson, and Dr. Charles F. Chandler. Do you find in the testimony of Mr. Nutter and Dr. Chandler, taken in connection with the description of the process practiced in the experimental machine at Basin as given by Mr. Hyde and Mr. Gibson, sufficient facts for making a determination of the amount of oleic acid in relation to ore used in the operation of said experimental machine at the time of Mr. Nutter's visit and removal of a sample?

A. Mr. Nutter, in his answer to Q. 15, states that he took a handful of froth concentrates out of "one of the froth-separating boxes from which a concentrate froth was flowing into a launder." It appears from the testimony of Gibson, answer to Q. 20, that there were five of these boxes, or "spitzkasten," three in the "rougher" and two in the "cleaner." Nutter testified that he was uncertain as to their number, but on his sketch has shown seven, lettered *a* to *g*. He says that he took the handful of froth from "box *f*," or the sixth one in order. This is evidently a mistake, as witness Hyde also testifies that there were but five of these frothing boxes or spitzkasten, and so indicates on his "Sketch of Experimental Machine" in evidence. Nutter further testifies that the pulp under treatment "was being brought into the plant by workmen in

buckets and wheel-barrows and fed into, I think, mixer No. 1." On his drawing, he shows ten mixers, the ninth of which delivers to frothing box *f*. As mixer 1 was, according to his sketch, at the other end of the plant from mixer 9, and as they were in two different units, his testimony shows nothing as to the kind or amount of the pulp, ore, oil, acid, or any other material in mixer 9. Nutter further testifies that, "As I recollect it, the ore was supplied to the flotation plant as a wet ore pulp or mud," evidently referring to the material brought in wheel-barrows and possibly fed into mixer 1. He states that he did not see oil being supplied to the material treated. From this random handful of concentrates from an alleged sixth frothing box, which did not exist, Professor Chandler draws certain conclusions as to the percentage of oil which was employed by the defendant, figuring it as "0.16 per cent. of oleic acid on the ore." This conclusion, however, is based on pure speculation, and is a guess. In making his calculations, he "assumed that that concentrate represented one-third of the original ore"; and he also assumed "one-third as much more for . . . loss on the tailings," here referring to oil carried into the tailings. There is no warrant whatever for these assumptions, so far as I can determine from the testimony of any witness. Gibson testifies that at the time Mr. Nutter entered the plant "The mill was down . . . and we were treating the concentrates made on the vanners, feeding it into the flotation machine by buckets"; that these materials were not an average

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grade of concentrates, whether higher or lower than the regular ore pulp, he could not say; and that the sample procured by Mr. Nutter was not a representative one of the product of the machine. The defendant, Mr. Hyde, also testifies, in R-D. Q. 135, as to the material being treated at the time Mr. Nutter entered the plant, that—

> "At that time, the machine was running upon the accumulated low-grade concentrates which had been produced upon the vanners. This was one of those numerous occasions which have previously been referred to upon which the main body of the mill was shut down, and the ordinary feed was not available for the experimental machine."

As Mr. Nutter made no observations whatever at the time of his visit as to the oil supplied to the material being treated; as the amount of oil added was never weighed or measured, and was variable according to conditions and the judgment of the operator (Gibson, Q. 13-Q. 15); as the material being treated at the time of Mr. Nutter's visit was vanner concentrates of unknown composition and grade, unknown ratio to the ore or ore-pulp ordinarily treated, and not representative of the ordinary pulp-feed; as these concentrates were simply dumped into mixer 1 by buckets, in an irregular and haphazard manner; and as the amount of mineral and oil which went into the tailings was unknown, I am clearly of the opinion that no legitimate conclusion whatever can be drawn from the

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percentage of oleic acid in the handful of froth taken away by Mr. Nutter, as to the ratio or percentage of oil relative to ore employed by the defendant, or as to whether or not it is within the limits specified in the patent in suit.

Q. 25. Will you state any instances with which you are familiar, whether in the metallurgical art or elsewhere, in which agitation of a substance is utilized as a means of aeration or as a means of introducing some other gas into such substance?

A. Aeration of a liquid by agitating it in the presence of atmospheric air and beating the air into and through it in the form of fine bubbles, to produce a froth, is an everyday operation with which we are all famaliar. I need only instance such domestic operations as the beating of eggs and the whipping of cream, or the soda-fountain operation of producing "milk-shake." It is customary in various arts to thus aerate liquid. For example, it is common to aerate soap while in the molten or liquid condition, to produce a material which will be light and float when solid. An agitator for this purpose, of the general type employed by defendant, is shown in an old book on the manufacture of soaps which I happen to have at hand. I refer to "A Treatise on Chemistry Applied to the Manufacture of Soap and Candles," by Campbell Morfit, copyrighted in the year 1856 and published in Philadelphia in 1860, by Henry Carey Baird. See the article on pages 271-272, "Flotant Soaps," and the accompanying figures 54 and 55. It is common in the production

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of butter to churn and beat air into the milk, the air diffused throughout it acting to throw down the curd and separate it from the butter. I refer, for example, to U. S. patent No. 373,113, granted November 15, 1887, to H. J. Wagner, page 2, lines 6-30. Instances of these methods might be indefinitely multiplied.

It is stipulated that the book by Campbell Morfit referred to by the witness was published and circulated during the year 1860.

Pages 271 and 272 of the book referred to by the witness are introduced in evidence, and marked by the Examiner "Defendant's Exhibit Extract from 'Treatise on Chemistry Applied to the Manufacture of Soap and Candles'."

The patent referred to by the witness in the foregoing answer is introduced in evidence, and marked by the Examiner "Defendant's Exhibit Wagner Patent 373,113."

Adjourned until Monday, May 13, 1912, at 10 A. M., same place.

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WASHINGTON, D. C., May 13, 1912.

Met pursuant to adjournment. Present, counsel as before.

Direct examination of Eugene A. Byrnes continued.

Printed Patent Office copies of the patents referred to by the witness are introduced in evidence, and respectively designated by the Examiner with the words "Defendant's Exhibit," and the the title of the patent, as follows:

Bradford Patent No. 345,951,
Everson Patent No. 348,157,
Hockley Patent No. 466,753,
Rouse Patent No. 469,599,
Hebron & Everson Patent No. 471,174,
F. E. Elmore Patent No. 653,340,
F. E. Elmore Patent No. 676,679,
A. S. Elmore Patent No. 689,070,
A. S. Elmore Patent No. 692,643,
Stoveken Patent No. 729,805,
Delprat Patent No. ~~735,381~~, 735.071
Glogner Patent No. 736,381,
Good Patent No. 745,960,
Delprat Patent No. 768,035,
Kendall Patent No. 771,075,
Potter Patent No. 776,145,
Cattermole Patent No. 777,273.
Cattermole, Sulman & Picard Patent No. 777,274,

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Cattermole, Sulman & Picard Patent No. 788,247,

Sulman and Picard Patent No. 793,808,

Schwarz Patent No. 807,501,

Schwarz Patent No. 807,503,

Kirby Patent No. 809,959,

Sulman Patent No. 835,143,

Sulman, Picard and Ballot Patent No. 835,479,

Kirby Patent No. 838,626,

Sulman, Picard and Ballot Patent No. 879,985,

Hyde Patent No. 1,022,085.

British Patent to Lake (Froment) No. 12,778, of 1902.

It is stipulated that this Lake (Froment) British patent was sealed on August 18, 1903.

By Mr. Williams: Counsel for defendant having agreed to file an amendment to the answer of defendant, including the prior patent above offered in evidence, patents Nos. 793,808 and 809,959, and the applications for patents not issued before the application for the patent in suit, subject to the condition heretofore stated, the objection of incompetency is now made, but will be withdrawn upon the filing of such amendment.

Certified copies of the applications for and proceedings in the United States Patent Office relating to United States patents Nos. 788,247, 793,808, 807,501, 807,503, 809,959, 838,626 and 835,120 are introduced in evidence, and marked by the Examiner as follows:

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"Certified Copy of File-Wrapper and Contents of Cattermole, Sulman & Kirkpatrick-Picard Patent No. 788,247."

"Certified Copy of File-Wrapper and Contents of Sulman & Kirkpatrick-Picard Patent No. 793,808."

"Certified Copy of File-Wrapper and Contents of Schwarz Patent No. 807,501."

"Certified Copy of File-Wrapper and Contents of Schwarz Patent No. 807,503."

"Certified Copy of File-Wrapper and Contents of Kirby Patent No. 809,959."

"Certified Copy of File-Wrapper and Contents of Kirby Patent No. 838,626."

"Certified Copy of File-Wrapper and Contents of Patent in Suit, No. 835,120."

BY MR. WILLIAMS: The objection of incompetency is now made as to the file-records of patents Nos. 788,247, 793,808, 807,501, 807,503, but will be withdrawn upon the filing of an amendment to the answer of the defendant, as above stated. It is to be noted, however, that statements made during the prosecution of other applications for patents than for the patent in suit and appearing in the above exhibits, are objected to as irrelevant and immaterial to the issues herein, and incompetent to prove any statements that may be made in such correspondence.

One of the two duplicate slide machines referred to and used by the witness J. M. Hyde and E. A.

Byrnes is introduced in evidence, and marked by the Examiner:

"Defendant's Exhibit Slide Machine."

The apparatus referred to by the witness E. A. Byrnes as having been made in accordance with Figure 1 of the drawing of the patent in suit is introduced in evidence, and marked by the Examiner:

"Defendant's Exhibit Apparatus of Patent in Suit."

The apparatus referred to by the witness E. A. Byrnes as having been made in accordance with Figure 1 of the drawing of Sulman and Kirkpatrick-Picard patent No. 793,808 is introduced in evidence, and marked by the Examiner:

"Defendant's Exhibit Apparatus of Patent No. 793,808."

It is stipulated by and between the parties hereto that the testimony of the witness James M. Hyde and Eugene A. Byrnes regarding the results of assays made by W. A. Hocking of Butte, Montana, and reported by him to said witnesses shall have the same force and effect as if said W. A. Hocking had been examined as a witness in this suit and had testified to the same effect as said witnesses in regard to said assays, the right of cross-examination being waived; but it is understood and provided that this stipulation does not waive the objection interposed by complainant following the answer of the witness E. A. Byrnes to question 17.

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It is stipulated that copies of the documents which were marked for identification during the taking of the deposition of the defendant, James M. Hyde, may be offered and used in evidence in place of the original documents, subject to the production of the originals upon reasonable demand.

Direct examination closed.

Cross-Examination by Mr. Williams, de bene esse, not waiving the objections and notices heretofore stated and given.

X-Q. 26. At the time that you were Principal Examiner of the Division of Metallurgy and Electrochemistry in the United States Patent Office, how many Principal Examiners were there in the Patent Office?

A. The number varied during this ten-year period, increasing, in a general way, from, say, twenty-five to thirty-five.

X-Q. 27. Were any of the patents to which you have referred in your testimony examined in the Division of Metallurgy and Electrochemistry?

A. Fourteen of the nineteen U. S. patents to which I have referred were granted since my resignation from the examining corps, and I have not examined the file-records to determine in what division they were considered. I do know that gas-flotation processes of the character in suit, so far as the art had been developed at the time of my resignation, were at least

largely examined in the division of Metallurgy and Electrochemistry. I remember personally acting on several applications of this class, including, I believe, applications of Charles B. Potter and Guillaume D. Delprat, grantees of two of the patents referred to by me. The art of flotation by a chemically-generated gas, as evolved by the action of mineral acids upon ores of the Australian "Broken Hill" type, was being actively developed during the latter part of my term as Examiner.

X-Q. 28. I have examined the original files in the Patent Office of the patent to Delprat No. 768,035 and the patent to Potter No. 776,145, these being the patents to these grantees referred to by you, and have not found your signature upon any action in the applications for these patents. I found that they were classified in Class 83, Mills, ore and coal washers. I note from the patents that the application for the Potter patent was filed January 14, 1902, and the application for the Delprat patent was filed January 2, 1903. Are you still of the opinion that you acted upon the applications for these patents?

A. I have not stated that I acted upon these particular applications, for this is an impossibility, since I resigned as Examiner, as stated in my answer to Q. 2, in November, 1901. What I did state was that among the applications on gas-flotation by the use of chemically-generated gas which I examined during the latter part of my term were, as I recollect, applications filed by these same inventors. I have a very

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definite recollection of the fact that applications on processes of this type were considered by me, and I also remember that these two inventors were among the earliest in this particular field. My interest in this subject was continued by the fact that subsequent to my resignation, I had clients who were working in the mineral-flotation art, including one who was operating on zinc sulfid ores, by a method which he considered an improvement upon that of Potter and Delprat, and another who was working on the flotation of sulfid ores by the film or surface-tension principle.

The classification of the Patent Office is constantly undergoing modification, and as the art in various lines grows, new divisions are established, and many rearrangements are made in the classes handled in any particular division. For example, the very large class of "Amalgamators," which was in my charge for some years, was subsequently transferred to the class which you mention, No. 83, "Mills." In view of the statement that the specified Potter and Delprat patents are now in this class, it is quite likely that there has been a further transfer of art from Division 3, the one which I had in charge, to Division 25, including "Mills." As to this, however, I am not informed, not having examined the file-records.

X-Q. 29. I note that the applications for the patents to Bradford, Everson, Hockley, Rouse, Hebron and Everson, and the four patents to Elmore were pending while you were in the Patent Office. Did you act as Examiner on any of these applications? I

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note that you, in your testimony, referred to only two of these Elmore patents, although four were introduced in evidence.

A. The Bradford and Everson patents were granted in 1886, before I was Examiner in the Division of Metallurgy.

I do not recall acting on the Hockley, Rouse, Hebron & Everson or Elmore patents, and it is quite possible that these were examined under the class of "Mills," as the line of demarkation between Divisions 3 and 25, handling "Metallurgy" and "Mills," was not entirely definite. As a rule, where ore-treatment involved some chemical reaction, such as that of acids on the constituents of the ore, the application was assigned to "Metallurgy"; where the separation was purely mechanical, to "Mills." The Hockley patent was referred to by me as a disclosure of the well known fact that finely-divided gold and silver will float on water, illustrating the principle of surface-tension flotation. There were many patents and applications for the recovery of "float gold" in the class of "Amalgamators," before I transferred it to "Mills." I do not recall whether or not this patent was one of them. Some patents and applications for the recovery of "float gold," involving electrochemical treatment, were retained in Division 3 when I established the present class of "Electrochemistry," which has a sub-class, "Ores," and the line between Divisions 3 and 25, on electrical amalgamators was very unsettled at the time I resigned.

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The Rouse patent, while describing a method of floating mineral as a froth by aeration, does not specify the use of acid, and quite likely was examined in Division 25, although as to this I have no recollection or knowledge.

The Hebron and Everson patent was cited by me as the one probably referred to in the Cattermole, Sulman & Kirkpatrick-Picard patent 788,247, as describing the mechanical flotation of mineral by particles of wood or other light material. It was quite likely examined in Division 25, under "Mills," although I do not know as to this.

The four Elmore patents offered in evidence relate to the flotation of mineral by oil *per se,* rather than gas. I cited two of them as illustrations of the preferential affinity of oil for mineral; and one, No. 689,070, as an illustration of the use of a very small amount of acid to increase the preferential affinity of oil for mineral, this being especially interesting on account of the fact that the corresponding British patent was the basis of a suit against the present plaintiff on this feature. I do not know where these Elmore patents are classified, but the flotation processes described therein do not rely on aeration or the evolution of a gas.

X-Q. 30. What explanation can you give of the phenomenon of the preferential affinity of oils for metalliferous constituents of ores, especially sulfids?

A. I take it that this is a matter of fact, and not of theory. It is a phenomenon, the knowledge of

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which is supposed to date back at least as far as Herodotus.

X-Q. 31. What explanation can you give of the action of acids in increasing the preferential affinity of oils for metalliferous minerals in an ore pulp?

A. I have no theory to account for this action. Possibly the acid slightly cleans the surface of the sufid. Possibly the acid itself has a preferential affinity for the gangue. Acidulated water seems to displace oil from the gangue, when mineral is present, as is stated in the Everson patent, and as I ascertained by experiments.

X-Q. 32. You have spoken of the fact that bubbles of air or gas in an ore-pulp attach themselves to greased metalliferous particles. To what do you attribute this phenomenon?

A. To the affinity of air or gas for grease.

X-Q. 33. When you say that the function of the air or gas bubbles is identical, whether they be shaken or beaten in, injected in streams, chemically or electrolytically generated in the pulp, produced by increasing and then diminishing the pressure on the pulp surface, produced by creating a partial vacuum over the pulp surface, or produced by boiling the pulp, do you mean that the action of the air or gas-bubbles is identical in all these cases?

A. I do. I mean that the same amount of air or gas, distributed in the same way in contact with the same amount, kind and size of oiled mineral particles, will have precisely the same flotative effect, whatever

the source of said air or gas, and however it be introduced or distributed. I, of course, do not mean to say that the same amount can be introduced and the same distribution effected by all these methods, or that air could be "chemically or electrochemically generated in the pulp," or "produced by boiling the pulp."

X-Q. 34. Do you understand this phenomenon to be a surface-tension phenomenon?

A. To a certain extent, yes?

X-Q. 35. Please explain more fully.

A. Froment, in his patent 12,778, of 1902, speaks of his observation that when natural sulfids are reduced to powder and are moistened by a fatty substance, and when a gas of any kind is liberated in the mass, the bubbles of the gas become covered with an envelope of sulfid. He refers to these coated bubbles as "metallic spherules." He also speaks of the fact that the metallic spherules, pressed one against the other, will become grouped in a magma clearly separated from the rest of the liquid.

The production and existence of bubbles is a phenomenon of surface-tension, and the relation and form, in a froth, of bubbles pressed together, is a very complicated matter, the mathematics of which has been considered by very learned men. When the mutual relations of solids, liquids and gases are involved, and the surface-tensions between them, the question becomes an extremely difficult one.

X-Q. 36. In commenting upon the Bradford patent, in which there is a disclosure of flotation of particles

on water by reason of air-films, you refer to the greased needle flotation phenomenon. Are these two phenomena attributable to the same cause, and if so, what is it?

A. In general, yes, specifically, no. The Bradford patent refers to the flotation of unoiled minerals, finely-divided, I have referred to the fact that when such particles are coated with a film of absorbed, or adherent air, they may float on water, because not wetted, or only slightly wetted thereby, lying on the surface of the water as on an actual skin or thin membrane, slightly depressed beneath them. A film of oil or grease on the surface of a sewing-needle tends to prevent actual contact of the needle with water, or its wetting with water, when it is laid gently on the surface of water, and thereby to bring into play the phenomenon of support by surface-tension. Doubtless in this case, also, there is a film of air surrounding the film of oil or grease.

X-Q. 37. In your discussion of the Sulman & Picard patent No. 793,808, you refer to the Froment, Potter and Delprat patents, in connection with a statement as to "the known method of chemically generating a gas to float the oiled particles." Do Potter and Delprat deal with oiled particles?

A. No. My reference was intended to be to the chemical generation of a gas, for the purpose of floating oiled particles, by the reaction of acid on carbonates or sulfids, as practiced by the patentees specified.

X-Q. 38. To what do you attribute the flotation

of unoiled particles of metalliferous matter in an ore-pulp, as disclosed by Potter and Delprat?

A. Delprat says:

> "This process is readily carried out at ordinary temperatures, and depends upon the ore particles being attacked by the acid to form a gas. Each ore particle so attacked will have a bubble or bubbles of gas adhering to it, by means of which it will be floated and can be skimmed or floated off to solution."

Potter says:

> "Heat being applied, the effect of the acidulated solution becomes apparent by the bubbling up and gathering on the surface of the fluid of the metallic concentrates in the form of a pasty mass."

Potter's claim 3 says:

> "forming a suitable solution containing sulfuric acid to react on the soluble sulfids present to form bubbles of sulphuretted hydrogen on the ore particles and thereby raise them to the surface."

X-Q. 39. I assume, therefore, that you accept the statements of these patentees and endorse them. Are these surface-tension phenomena?

A. Necessarily so, since solid particles, liquid and bubbles of gas, are in mutual contact. The surface-tension phenomena are, however, much more compli-

cated than the simple flotation of a single aerated or oiled particle lying on the surface of the liquid.

X-Q. 40. Now dealing with the attachment of a bubble of gas to a particle of metalliferous mineral in the body of an ore-pulp, is this a surface-tension phenomena?

A. Yes.

X-Q. 41. In the case of the Potter and Delprat processes, do you understand that there is any moving together, followed by attachment, of the bubble of gas and the mineral particle?

A. If I understand the question, no, since the attached bubble of gas is generated *in situ* by the reaction of the acid on the particle itself. Of course some bubbles of the gas generated might shift to another particle or particles, or several particles might adhere to one bubble.

P. 1581, L. 20, insert " and bubbles of air or gas in this body of ore pulp " before, " what "

particles and bubbles.

X-Q. 43. What would be necessary in order to bring about an interaction between the oiled metalliferous particles and the bubbles of air or gas, under the conditions stated in the last question?

A. Assuming that "interaction" here includes adhesion, I should say that contact between the oiled particles and bubbles would be the first essential.

X-Q. 44. In your description of experiment No. 4 of

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of unoiled particles of metalliferous matter in an ore-pulp, as disclosed by Potter and Delprat?

A. Delprat says:

> "This process is readily carried out at ordinary temperatures, and depends upon the ore particles being attacked by the acid to form a gas. Each ore particle so attacked will have a bubble or bubbles of gas adhering to it, by means of which it will be floated and can be skimmed or floated off to solution."

Potter says:

> "Heat being applied, the effect of the acidulated solution becomes apparent by the bubbling up and gathering on the surface of the fluid of the metallic concentrates in the form of a pasty mass."

> acid to react on the soluble sulfids present to form bubbles of sulphuretted hydrogen on the ore particles and thereby raise them to the surface."

X-Q. 39. I assume, therefore, that you accept the statements of these patentees and endorse them. Are these surface-tension phenomena?

A. Necessarily so, since solid particles, liquid and bubbles of gas, are in mutual contact. The surface-tension phenomena are, however, much more compli-

Deposition of Eugene A. Byrnes.

cated than the simple flotation of a single aerated or oiled particle lying on the surface of the liquid.

X-Q. 40. Now dealing with the attachment of a bubble of gas to a particle of metalliferous mineral in the body of an ore-pulp, is this a surface-tension phenomena?

A. Yes.

X-Q. 41. In the case of the Potter and Delprat processes, do you understand that there is any moving together, followed by attachment, of the bubble of gas and the mineral particle?

A. If I understand the question, no, since the attached bubble of gas is generated *in situ* by the reaction of the acid on the particle itself. Of course some bubbles of the gas generated might shift to another particle or particles, or several particles might adhere to one bubble.

X-Q. 42. Now assume oiled metalliferous particles in a body of ore-pulp, what action takes place?

A. The question is too vague to admit of a definite answer, since it does not state the relation of the oiled particles and bubbles.

X-Q. 43. What would be necessary in order to bring about an interaction between the oiled metalliferous particles and the bubbles of air or gas, under the conditions stated in the last question?

A. Assuming that "interaction" here includes adhesion, I should say that contact between the oiled particles and bubbles would be the first essential.

X-Q. 44. In your description of experiment No. 4 of

your seven numbered experiments in connection with the Froment patent, you say you added a few drops of sulfuric acid. How much sulfuric acid did you add and of what strength?

A. I think about five drops of concentrated acid.

X-Q. 45. Did you make any measurements that would indicate the amount of these five drops in weight or otherwise?

A. Only by counting them as they dropped from the burette containing the acid.

X-Q. 46. You also say that the mixture was gently heated. To what temperature was it heated?

A. It was heated by placing it in the warm water running from the spigot at the sink. I did not take the temperature by a thermometer.

X-Q. 47. In your experiment 5, you say you added one drop of olive oil. Can you give the weight of this drop of oil or otherwise describe it so that the experiment may be duplicated?

A. I did not weigh this drop, or one like it. The same amount can be obtained by dropping the oil from a burette such as I used to transfer the oil from its bottle to the test tube. This burette was one of the usual kind, having a cylindrical bore about one foot long, designed to deliver one cubic centimeter, and graduated in tenths of a cubic centimeter.

X-Q. 48. In your experiment 6, you again say that the "whole was gently heated." In what manner and to what temperature was this heating accomplished?

A. By warm water from the spigot, as before, to a temperature not measured by a thermometer.

Deposition of Eugene A. Byrnes.

X-Q. 49. Again, in experiment 7, you state "a few drops of sulfuric acid." How many, of what strength and of what weight?

A. About five drops of concentrated acid, as delivered by the ordinary fifty cc. burette having a glass stop-cock.

X-Q. 50. Was this same burette used for dropping sulfuric acid wherever used in these seven experiments?

A. Yes.

X-Q. 51. In carrying out a test of a process of separation alleged by you to correspond to that of the Kirby patent, No. 809,959, you say you agitated the mixture in the slide machine which you designate the "Hyde Slide Machine." At what speed did you rotate the agitator?

A. About sixteen hundred revolutions a minute.

X-Q. 52. Did you measure this speed of rotation?

A. Yes. That is, I measured the speed of the electric motor while driving it, by a tachometer, and employed pulleys on the motor and agitator shafts of practically the same diameter.

X-Q. 53. In your description of the test in which you allege you carried out the process of the Schwarz patents 807,501 and 807,503, you mention agitation but do not give the speed of rotation of the agitator shaft. What was this speed?

A. The same as before, about sixteen hundred revolutions per minute.

X-Q. 54. Is this also true of the test next described by you, in which you alleged that you carried out the operations of the Everson patent 348,157?

A. Yes.

X-Q. 55. In your description of tests of the apparatus which is in evidence as "Defendant's Exhibit Apparatus of Patent No. 793,808," you say that the coil of pipe was rapidly rotated. At what speed was it rotated?

A. I ran this apparatus both in Butte, Montana, and in Washington, D. C., in each case driving it by a belt from the stepped cone of an engine lathe. I shifted the belt from step to step until I obtained as high a speed as possible, without the belt slipping or throwing off. I had no means at hand at either place for measuring the speed, but judge that it was several hundred revolutions per minute.

X-Q. 56. In certain tests described by you as under the process of the Froment British patent, using the "Hyde Slide Apparatus," you speak of brief agitation, but do not give the period of agitation or the speed of rotation of the agitator shaft. Please supply these particulars as nearly as possible?

A. In general, the first agitation was for a period of thirty seconds, and the subsequent agitations about ten to twenty seconds each. The speed of the agitator was about sixteen hundred revolutions per minute.

X-Q. 57. You next describe tests of an apparatus introduced in evidence as "Defendant's Exhibit Apparatus of Patent in Suit," and say that the cone mixer was rapidly rotated. At what speed was it rotated?

A. It was driven by the same electric motor as that used with the Hyde slide machine, having a speed of

Deposition of Eugene A. Byrnes.

sixteen hundred per minute. The pulleys on the shaft of the motor and cone agitator were about the same size. I ran the cone at as high a speed as I could without the quarter-inch round leather belt slipping, increasing the tension slightly on the belt as the agitator ran more heavily. There was some tendency for the cone to clog with ore, and also for ore to work into the step at the lower end of the agitator shaft and increase the frictional resistance. This step ground out considerable in use, however, so that the shaft did not bind so much in the later work.

X-Q. 58. I take it that you did not measure the speed of rotation during this test.

A. No, not that of the cone shaft. I could not keep the tachometer on its upper end, on account of its lateral vibration. The standard carrying the bearings for the upper end of the shaft was not sufficiently inflexible to hold the bearings rigidly in place.

X-Q. 59. Did you measure the speed of the motor while it was subjected to the load of the work of rotating this cone-agitator during the agitation for ten minutes or during any other actual use of this apparatus?

A. Yes. The motor which I used in my laboratory was a single-phase one of the constant-speed type. I allowed it to run at its normal speed, sixteen hundred revolutions per minute, regardless of the load, decreasing the tension on the belt if necessary to enable it to keep up the speed.

Adjourned until Tuesday, May 14, 1912, ten A. M., same place.

Deposition of Eugene A. Byrnes.

WASHINGTON, D. C., May 14, 1912.

Met pursuant to adjournment. Present, counsel as before.

Cross-examintion of Eugene A. Byrnes continued.

X-Q. 60. You have made the positive statement that the slide machine used by you in your tests was "designed in part by the defendant." What is the source of your knowledge of this fact?

A. The defendant.

BY MR. WILLIAMS: Notice is given of a motion to strike out the part above quoted of the answer to question 4 as hearsay and incompetent.

X-Q. 61. You have introduced into this record for the first time the name of the Black Rock mine of the Butte & Superior Copper Company, and have apparently confined your investigations and tests relative to the ores used by defendant to this mine and its product. Please state your reason for doing so.

A. The alleged infringement, as I understand it, is the use of the process in suit for the treatment of the ore from this mine. I was therefore especially interested in determining whether the processes of the prior art were adapted for the treatment of this ore, which I found to be the case. Furthermore, this ore is one which I should *a priori* judge to be a proper one for treatment by the various oil-gas flotation processes set forth in the prior art, since its important metalliferous

constituent, to the extent of thirty per cent., is zinc sulfid, and since it invariably contains a carbonate easily decomposable by sulfuric acid to evolve a gas.

X-Q. 62. In your answer to Q. 23 you say that you do not know of any oil-gas flotation process for the separation of minerals ever having been commercially operated in this country, other than the operation of the defendant, Mr. Hyde. Please explain what you intended to include by "oil-gas flotation process." You will note that I have combined the question and answer referred to in my question.

A. By the expression "oil-gas flotation process," I understood a process for the flotation of the metalliferous constituents in ore, based upon the preferential affinity of oil for this constituent and of gas for the oil, that is, one in which the mineral particles are oiled and are then floated by attached bubbles or films of air or gas.

X-Q. 63. What patents referred to by you did you intend to include within this definitive term?

A. My answer in question did not relate to the prior art as set forth in the patents cited in my answer to Q. 4, but to the commercial operation of a process of this type.

X-Q. 64. Described in what patents?

A. Whether described in any patent, or in none.

X-Q. 65. What patents referred to by you describe oil-gas flotation processes?

A. I should say that the following patents referred to by me describe oil-gas flotation processes, that is,

Deposition of Eugene A. Byrnes.

processes in which the mineral particles are oiled and then floated by attached bubbles or films of air or gas:

348,157, to Everson.
736,381, to Glogner.
745,960, to Good.
788,247, to Cattermole & Kirkpatrick-Picard.
793,808, to Sulman & Kirkpatrick-Picard.
807,501, to Schwarz.
807,503, to Schwarz.
809,959, to Kirby.
838,626, to Kirby.
British 12,778 of 1902 to Froment.

Furthermore, as I have heretofore stated, the amounts of oil specified in the Cattermole patent 777,273 and in the patent in suit overlap each other, or may be the same as applied to many ores, and since precisely the same cone agitator is used in both, the two processes may become identical. In other words, while Cattermole describes his process as one of agglomerating the oiled mineral particles into heavy granules which sink, and while the patentees in suit describe their process as one of aerating and floating oiled mineral particles, it is obvious that when the same amount of oil is used on the same ore, with the same agitator, the same conditions will give the same result in both cases, so that the Cattermole process will float the same amount of mineral as the process in suit. And in view of my experiments in which I used amounts of various oils as great or greater than the percentages specified by Cattermole,

when based on the weight of metalliferous mineral matter present in the "Black Rock" ore, with a more efficient agitator than that shown by Cattermole and adopted by the patentees in suit, and obtained a very high recovery by aeration and flotation of the oiled mineral, I should say that the process of this Cattermole patent itself, at least as applied to the "Black Rock" ore and with the kinds of oil used by me, is one of oil-gas flotation. And this opinion would equally apply to the process of the Cattermole, Sulman & Kirkpatrick-Picard patent 777,-274.

X-Q. 66. Do you know of any commercial use in the United States of the treatment of ores of the processes disclosed in any of the patents referred to by you in your testimony and not included in the answer which you have just given?

A. I think the processes of the Elmore patents 676,-679 and 689,070, have been commercially tested in this country, though I cannot say positively as to this. I am quite sure that processes of the type described in the Delprat patent 735,071 and Potter patent 746,145 have been used in this country, although I do not just now recall where or to what extent, aside from the method of this type used by my own client, heretofore referred to. I think the process of the Kirby patents 809,959 and 838,626 has been operated in this country or in Canada; but whether or not to an extent which would be termed "commercial" I do not know, and this is an impression rather than a definite recollection.

In this answer, and that to X-Q. 65, I of course do

not include the process patented to the defendant, and in use by him at Basin, Montana.

X-Q. 67. Do you know of any present use in the United States, commercially, in the treatment of ores, of the processes of the Elmore, Delprat, Potter or Kirby patents?

A. I have at present no positive recollection as to such use.

X-Q. 68. In describing the defendant's apparatus as examined and tested by you at Basin, Montana, during April of the present year, you say that the pulp is delivered through an iron pipe from the third agitation vessel of the first cell to the flotation-box. Please describe this iron pipe as to internal diameter, length and position.

A. This pipe was of wrought iron, in three pieces joined by two ells. I did not measure its internal diameter, but judge that it was about 4 inches. It extended from the end of the third agitation vessel horizontally outward perhaps 2 feet, where it was united by an ell at right angles to another horizontal piece extending forward a few feet to the side of the flotation-box. The end of this latter piece was united by an ell to a third horizontal piece extending at right angles to the second and into and through the side of the flotation-box, near its top and back, as viewed from the platform extending along the front of this box.

X-Q. 69. At what part of the agitation vessel did this pipe emerge therefrom?

A. From the end near the bottom, just above the floor of the vessel.

Deposition of Eugene A. Byrnes.

X-Q. 70. Was a similar pipe used for connecting each of the other flotation-boxes with its agitation vessel?

A. Yes.

X-Q. 71. Please describe the construction of the flotation-box which was present in this apparatus.

A. This box had vertical rear and side walls. Its front wall inclined outward and upward at an angle of about 30° to the rear wall, which it nearly joined at the bottom. It was built of heavy plank, was entirely open at the top, and had at its front edge, adjacent to the platform, a depressed portion or lip, over which the froth with some water was discharged into the launder just below.

X-Q. 72. You say that the level of the water in the first flotation-box can be regulated by a valve. Where is this valve located and how did it effect this regulation?

A. A large iron pipe, probably 4 inches in internal diameter, extended laterally and thence upwardly from the lower end of the flotation-box, delivering into the agitation vessel, or first agitation vessel, of the next "cell." In the lower horizontal portion of this pipe was a revoluble through-plug, from which an operating shaft extended upward to a point near the top of the flotation-box, where it had a handle. By turning this plug or cock the outflow through the pipe could be regulated. However, as the floors of the agitation vessels were at a higher level than the surface of the water in the flotation-boxes, it was necessary to lift the pulp discharged from the bottom of each flotation-box to the

next vessel. For this purpose a stream of compressed air, regulated by a valve, was admitted to this pipe at the union of its horizontal and vertical portions. Increasing the supply of air increased the rate of discharge from the flotation-box, and correspondingly lowered the level therein.

X-Q. 73. At what part of the first agitation vessel of the next cell did this pipe enter it?

A. The side, a short distance above the bottom.

X-Q. 74. Near the middle or near an end of the side?

A. I think near the middle.

X-Q. 75. Does the description which you have given of the connection from the bottom of a flotation-box to the first agitation vessel of the next cell apply equally to all of the connections of this character in this apparatus?

A. Yes.

X-Q. 76. You have described the agitator as having four radial stirring arms. Did these arms have inclined faces, as shown in the Hyde patent No. 1,022,085, or vertical faces, as in "Defendant's Exhibit Slide Machine"?

A. Vertical faces.

X-Q. 77. In describing your first test with cotton-seed oil in this apparatus, you say you ran the cotton-seed oil into the agitator at about three times the rate of speed which was customary with the red oil. How did you determine that this was the rate of feed?

A. By measuring the two rates.

X-Q. 78. And how did you measure them?

A. By noting the amount discharged into a glass cyl-

Deposition of Eugene A. Byrnes.

inder graduated in cubic centimeters, in a noted time, fifteen or thirty seconds.

X-Q. 79. What did you thus determine as the rate of speed in each instance?

A. While I can hardly say that there is any "normal" rate of feed for the red oil, I did determine this rate on different occasions, finding it to be, in one test, about 100 cubic centimeters per minute, and in another about 120. In using cotton-seed oil, I first ran at 300 cubic centimeters per minute, which I denominated "three times the rate of feed which was customary with the red oil." I afterward ran with the valve open to its full limit, then discharging 735 cubic centimeters per minute, to which I added, in a separate stream, 30 cubic centimeters of red oil per minute.

X-Q. 80. Did you measure the rate of feed or the state of dilution of the pulp which was fed to the first agitation vessel?

A. No.

X-Q. 81. Did you measure the amount of concentrates or the amount of tailings discharged from the apparatus in any given time?

A. No. Both the feed of pulp and discharge of froths and tailings was quite variable, necessitating constant regulation of conditions. The operations being continuous, I did not attempt to interrupt them to determine if there was any average rate of supply or discharge of froths and tailings.

X-Q. 82. What would be your estimate of the hourly or daily capacity of the appartatus expressed in any terms?

Deposition of Eugene A. Byrnes.

A. I could not give even an approximate figure.

X-Q. 83. What were the general dimensions of each agitation vessel?

A. Inside measurements, about 28 inches square and four feet deep.

X-Q. 84. What were the general dimensions of each flotation box?

A. About three feet wide, five feet from front to rear at the top, and seven feet deep.

X-Q. 85. Please describe the connection from the third flotation box of the cleaner to the first agitator of the second cell of the rougher?

A. The tailings were lifted through a vertical iron pipe, by a centrifugal pump, to a point at such height that they could be run by a launder into the agitation vessel.

X-Q. 86. Where did this launder enter the agitation vessel?

A. It discharged into its open top.

X-Q. 87. Did you measure the speed of rotation of the agitator blade of this apparatus?

A. No.

X-Q. 88. You are familiar, are you not, with a publication in the Engineering & Mining Journal, of November 15, 1890, relative to the Everson process?

A. Yes, assuming that you refer to the article on page 581.

Cross-examination closed.

EUGENE A. BYRNES.

Deposition closed.

Notary's Certificate.

It is stipulated and agreed that the further taking of testimony upon behalf of defendant may be and is adjourned to such time and place and before such examiner as the court may direct or as counsel herein might agree upon.

UNITED STATES DISTRICT COURT, DISTRICT OF MONTANA.

Minerals Separation, Limited, and Minerals Separation American Syndicate, Limited, *Complainants,* *vs.* James M. Hyde, *Defendant.*	In Equity. No. 1076.

District of Columbia, City of Washington, ss.

I, Joseph H. Blackwood, a Notary Public, Special Examiner by consent of counsel in the above-entitled cause, hereby certify that the foregoing depositions of James M. Hyde and Eugene A. Byrnes were taken before me directly on the typewriter after the witnesses had been duly sworn to testify the truth, the whole truth and nothing but the truth, and when completed were read over by the said witnesses and signed by them in my presence; that the said depositions were taken, pursuant to notice and agreement between counsel, at the offices of Byrnes, Townsend & Brickenstein, 918 F St., N. W., Washington, D. C., commencing on Wednesday, April 24, 1912, and continuing on April

Notary's Certificate.

25th, 26th, 29th, May 1st, 2nd, 3rd, 6th, 8th, 9th, 10th, 13th and 14th; that the complainants were represented by Henry D. Williams and the defendant was represented by J. Bruce Kremer and Walter A. Scott; that the several exhibits therein cited were offered in evidence and were marked as therein noted; that I am not of counsel for either party to this cause, nor related by blood or marriage to any member of either of the complainant corporations or the defendant, and that I am not interested directly or indirectly in the matter in controversy.

In testimony whereof I have hereunto set my hand this 1st day of June, 1912.

JOSEPH H. BLACKWOOD,
Notary Public, District of Columbia.

Order.

At a Stated Term of the United States District Court in and for the District of Montana, held at the Court House in Butte, Montana, this 6th day of July, 1912.

Present: Hon. George M. Bourquin, Judge.

Minerals Separation, Limited, and Minerals Separation American Syndicate, Limited,
Complainants,
vs.
James M. Hyde,
Defendant.

In Equity.
No. 1076.

Order.

On motion of defendant, and on reading and filing the stipulation hereto annexed, and with the consent of the complainants, it is

Ordered, that a commission be issued in this cause out of this Court, directed to Joseph Phillips Crawley, of 9 Bishopsgate, London, England, a Notary Public, residing in London, England, to examine the following named persons under oath as witnesses herein, viz.:

Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard, John Ballot, D. P. Mitchell, Francis E. Elmore, Alexander S. Elmore, Herbert C. Hoover, Theodore J. Hoover, and such other witnesses as defendant shall desire to examine. It is further

Ordered, that the examination above provided for shall take place during the months of August and September, in the year 1912. It is further

Order.

ORDERED, that either party to this action may examine not only the witnesses herein named, but any other witnesses that either party may desire to examine in Great Britain; provided, however, that the names of said witnesses and their places of residence shall be given to counsel for the opposing party in England not less than two days prior to the examination of each of such witnesses, and provided further that the examination of witnesses in behalf of defendant shall be first completed and closed and defendant's testimony closed, and that thereafter complainants may examine either of the said witnesses or other witnesses in rebuttal of defendant's testimony taken in the United States or under the commission. It is further

ORDERED, that counsel for each of the parties hereto shall give notice to opposing counsel, before the taking of depositions under this order shall be commenced, of his address in London, and delivery of notices herein provided for at such address shall constitute sufficient service thereof. It is further

ORDERED, that, all directions herein contained as to time, place, order and manner of examination of said witnesses, may be changed or modified by written consent of counsel for the respective parties, and that by written consent of counsel the examination of said witnesses may be conducted by and before a Notary Public or other official authorized to administer oaths other than the Commissioner herein particularly designated. It is further

ORDERED, that the examination of all witnesses under

Order.

this commission shall be oral, or taken by question and answer in the usual manner of taking oral depositions by examination, cross-examination, and re-direct examination; that the testimony given under such examination shall be reduced to writing, signed by the witnesses and certified by the Commissioner, and by him transmitted by mail to the clerk of this court at the City of Helena, Montana, unless otherwise mutually agreed upon by said counsel for both parties. It is further

ORDERED, that all testimony taken under the commission provided for herein shall be taken subject to all legal objections at the trial of this action.

GEORGE M. BOURQUIN,
Judge of the District Court for
the District of Montana.

Stipulation.

UNITED STATES DISTRICT COURT, DISTRICT OF MONTANA.

Minerals Separation, Limited, and Minerals Separation American Syndicate, Limited, *Complainants,* *vs.* James M. Hyde, *Defendant.*	In Equity. No. 1076.

STIPULATION.

It appearing that the defendant wishes to examine on open commission, at London, England, the witnesses whose names are stated in the preceding proposed order, and such other witnesses as defendant shall desire to examine, with the expectation of proving, particularly, the following facts:

1. That the patent in suit does not disclose anything that was not well known to the public long prior to the date of said patent.

2. That the patent in suit does not set forth an operative process, or one that has ever been of commercial utility.

3. That such commercial operations as have been conducted by the complainants have not been in accordance with the process set forth in the patent in suit.

4. That the patent in suit is deceptive and void under the provisions of R. S., Section 4920.

5. That the defendant was not, while in the employ of Minerals Separation, Limited, one of the complainants, instructed by the joint patentees or by other en-

Stipulation.

gineers and experts in the employ of said Minerals Separation, Limited, in technical details and particulars as to the patent in suit and the installation and use of the process of ore concentration set forth therein.

6. That the three joint patentees are not the original and joint inventors of anything set forth and claimed in the patent in suit.

And it also appearing that the complainants desire to examine witnesses in London in rebuttal of defendant's testimony as heretofore taken in the United States, or as it may be brought out under this commission in the testimony taken in London;

And it also appearing that the witnesses named, and others who may be able to testify relative to the alleged facts as above and in rebuttal, cannot be examined in the United States, and that the facts which defendant expects to prove in support of his defense, and that the facts which complainants expect to prove in rebuttal thereof, cannot be adequately or completely proved by witnesses within the United States;

It is hereby stipulated, consented and agreed by and between counsel for the respective parties that the preceding order may be entered and filed and a commission be issued pursuant thereto.

McConnell & McConnell,
Solicitors for Complainants.
Kremer, Sanders & Kremer,
Solicitors for Defendant.

Deposition of Henry L. Sulman.

UNITED STATES DISTRICT COURT, DISTRICT OF MONTANA.

Minerals Separation, Limited, and Minerals Separation American Syndicate, Limited, *Complainant,*

vs.

James M. Hyde, *Defendant.*

In Equity. No. 1076.

Depositions of witnesses in behalf of defendant in the above-entitled suit, taken pursuant to a commission issued out of the above-entitled court July 6, 1912, before Joseph Phillips Crawley, of 9, Bishopsgate, London, England, a Notary Public and the Commissioner named in said commission, at the office of Boult, Wade & Tennant, 112, Hatton Garden, Holborn Circus, London, E. C., commencing this 6th day of August, 1912, at 12 o'clock noon.

Present: Walter A. Scott, Esq., counsel for defendant; Henry D. Williams, Esq., counsel for complainants.

HENRY LIVINGSTONE SULMAN, a witness produced on behalf of defendant, having been duly cautioned and sworn, testifies as follows:

Direct Examination by Mr. Scott.

Q. 1. What is your name, age, residence and occupation?

A. Henry Livingstone Sulman; age 51; residence 31, The Avenue, Brondesbury Park, London, N. W.; I am

Deposition of Henry L. Sulman.

by profession a consulting metallurgist and assayer, and my place of business is Sulman & Picard, 44, London Wall, London, E. C.

Q. 2. Are you the Henry Livingstone Sulman named as one of the grantees of the United States letters patent No. 835,120 involved in this suit?

A. I am.

Q. 3. Will you please state when you first learned of the use of oil or fatty matter as a means of separating part of the constituents of an ore by flotation?

A. I first learned of the use of oil to separate particles of mineral of an ore by flotation due to the buoyancy of oil in about June, 1894.

Q. 4. Will you state when you first learned of the use of oil or fatty matter in connection with the supplemental action of a gas as a means of floating parts of the constituents of an ore, the ore being suspended in water as a pulp?

A. I first learned of the concomitant use of a gas with an oily substance and as an essential concomitant to flotation about July, 1903. In this answer I do not refer to the more or less accidental presence of some air bubbles in the Elmore oil buoyancy process; but prior to this I had noticed the tendency of oiled mineral to float at a water surface or when brought into contact with bubbles of air during the prosecution of researches into the Cattermole process.

Q. 5. Will you describe somewhat in detail the process in which gas and an oily substance were concomitantly used as referred to in your last answer?

Deposition of Henry L. Sulman.

A. In carrying out the Cattermole process wherein the metallic constituents are formed into granules in an aqueous pulp by means of oil, these granules being of sensible size can be separated from the gangue material of lower specific gravity in a water upcast. It was noticed under certain conditions that if ~~the~~ air bubbles were introduced by accident into such upcast they would tend to float up some of the granules and also some of the insufficiently oiled mineral to the top of the upcast where they were lost by being carried away with the gangue. This was always regarded by us during the first stage of the Cattermole process development as a disadvantage to that process and means were taken subsequently to again sink any metallic portions so floated.

Q. 6. I understand from your answer to question 4 that about July, 1903, you had learned of the intentional use of a gas with an oily substance to produce flotation. If I am correct in this will you describe the process so referred to?

A. A pulp of the ore containing the mineral which it was desired to separate was mixed with a small quantity of oil insufficient to float the mineral by the buoyancy of the oil alone and mixed sufficiently to ensure the attachment of small quantities of oil to the mineral. A gas was then liberated in or generated in the pulp so prepared and it was found that such gas had a tendency to attach itself to the oiled particles. If air were used this was liberated by blowing a stream of bubbles through the mixture in several ways, and if a gas other than air were employed this was generated in the liquor by chemical reactions or by electrolysis.

Deposition of Henry L. Sulman.

Q. 7. Where did you see this process operated?

A. This process was devised in the laboratory of my firm at 44 London Wall. It was only experimentally tried on a small scale there.

Q. 8. By whom was this process originated?

A. By Mr. Picard and myself and at a later date Mr. Cattermole co-operated with us in a further development.

Q. 9. Was this the first process of which you learned in which the joint action of oily matter and a gas were utilized for the purpose of floating part of the constituents of an ore?

A. That is my memory of the first time that I learned of the essential use of a gas towards flotation of oiled mineral, although I subsequently found this knowledge had been antedated by Mr. Froment.

Q. 10. And about when, if you remember, did you learn that Mr. Froment had practiced such a process?

A. I learned of the Froment process from the abstract of a patent which was published in the Journal of the Society of Chemical Industry which I saw in August, 1903.

Q. 11. Did you ever yourself operate or see others operate Mr. Froment's process to which you have referred?

A. I have only seen the Froment process operated and have only operated it myself on a small scale in the laboratory or works laboratory. My experiments on the Froment process were confined to test tubes, bottles or somewhat larger vessels. A somewhat larger apparatus

was obtained from Mr. Froment at a later date, but I never saw this effectively worked. Efforts were made to work this apparatus but with no successful result.

Q. 12. Will you state what the somewhat larger vessels were?

A. They were glass vessels, cylinders and such shaped vessels as were at that time used by us in the Cattermole process and might have had a capacity of 1 to 2 litres.

Q. 13. Will you describe somewhat in detail the procedure followed in operating the Froment process with bottles, test tubes and the larger vessels to which you have referred?

A. We made our experiments by following the instructions given in Froment's British specification. We added the ore to a liquid, water, to form a pulp (freely flowing pulp), and also added to this a substance capable of being decomposed by a dilute acid for the purpose of generating a gas; such, for example, as calcite, whiting, or carbonate of soda. A quantity of oily matter sufficient to form a thin layer was then added upon the surface of the pulp and the whole was then well mixed. A small quantity of acid was then added to the mixture with suitable gentle stirring to bring the acid and the gas-producing substance into contact and thereupon the oiled mineral was floated to the surface by the bubbles of the generated gas.

Q. 14. Did you follow Froment's instructions contained in his British specification 12,778 of 1902 in the matter of agitating the mixture of the ingredients you have named?

Deposition of Henry L. Sulman.

A. I did agitate gently for the purpose I have stated, that is, to bring the acid into contact with the decomposable substance. A greater degree of agitation was found harmful in producing the flotation as the type of float material produced was such as very readily broke up, in my experience, and anything like vigorous agitation defeated the object of the invention.

Q. 15. Was this Cattermole process to which you have referred in which it was desired to form the metallic constituents into granules ever operated commercially, that is, I mean for the purpose of profits in concentrating ores?

A. Not by myself, but I believe it was worked profitably for a period in Australia.

By Mr. Scott: The reference to the use of the Cattermole process in Australia is objected to as hearsay.

Q. 16. I understand from your answer that you have no personal knowledge that the Cattermole process was ever operated commercially?

A. I have not myself operated the Cattermole process for profit but was instrumental with others in designing and erecting a small scale plant which would treat considerable quantities of ore and this model plant was sent out to Australia. Beyond this I cannot go as to the commercial working of the Cattermole process.

Q. 17. Referring to your description of your procedure in operating the Froment process, you have stated that you gently stirred the mixture to bring the

acid and the gas-producing substance into contact. Is stirring or agitation necessary in that process for any other purpose than to bring the acid into contact with the gas-producing substance?

A. Agitation in my experience of the Froment process should be given in two stages. Sufficient agitation firstly to get the oil into efficient contact with the mineral to be subsequently floated. This first agitation is not responsible for the production of the float material required. The second agitation is for the purpose of effecting the due contact and uniform contact of acid with the decomposable substance and much less agitation is required and in my experience is necessary for the second purpose, having regard to the nature of the float material produced.

Q. 18. In all oil flotation processes sufficient agitation is necessary, is it not, to distribute the oil in such a manner that it will come into contact with the particles for which it has an affinity?

A. The first requisite of any oil concentration process is to obtain efficient contact between the oil and the mineral and suitable methods must be employed to effect this. Where the oil is in large relative quantity to the mineral violent agitation is unnecessary and may be very harmful. With decreasing proportions of oil more vigorous agitation or mixing is necessary to ensure such efficient contact of oil with the mineral particles. The agitation may therefore be said to be roughly proportioned to the work to be done in bringing about contact between large or small quantities of oil in regard to the mineral.

Deposition of Henry L. Sulman.

Q. 19. At the time you first learned of the Froment process in August, 1903, were you connected with Minerals Separation, Limited?

A. I do not recall the date without reference to the formation of Minerals Separation, Limited, but I was associated with the various gentlemen who formed Minerals Separation, Limited.

Q. 20. In operating the Froment process what kind of oil did you use?

A. We tried a large variety of oil. Hydrocarbons, heavy and light, certain fatty oils also.

Q. 21. Will you give the specific names of these oils which you tried?

A. Heavy and light lubricating oils, cylinder oils, lighting oils and even light volatile hydrocarbons. At this length of time I cannot recall all that were used, but I think of turpentine, oleines. There were doubtless others, but I do not recall them specifically. Every effort was made to locate the factors which would make the Froment process successful and I know that a variety of oils were therefore experimented with to this end.

Q. 22. What kind of an apparatus did you use when you first operated, or saw operated by others, the process set forth in the patent in suit?

A. The apparatus that I first saw the agitation froth produced in as described in the specification referred to was the ordinary gabbet apparatus consisting of a vessel with rotating cone and with suitable baffles. The cone was rotated at a high rate of speed, about

1000 revolutions per minute, and the size of the vessel was such as would contain about 2 litres of liquid.

Q. 23. How was the concentrate removed from the remainder of the material when this apparatus was used?

A. When I first saw this thick froth produced it was so coherent and resistant that we were able to remove the greater portion by spooning it or ladling it from the surface of the liquid. But this was necessarily an imperfect method and a funnel with a long stem was then introduced into the liquid below the froth and water poured in through the funnel until the froth was floated over the rim of the containing vessel and the overflow caught in a basin placed beneath it.

Q. 24. Where did this operation take place?

A. This took place in the experimental laboratory of Minerals Separation, Limited, at Aldermanbury Avenue, London, E. C.

Q. 25. Did you operate the process in any other manner at the laboratory referred to by you in your last answer?

A. Subsequently we fitted a spitzkast or spitzlutte apparatus to the battery of agitation vessels, and at the end of the series of these, upon which spitzkast or spitzlutte the agitation froth was floated off and the gangue allowed to sink.

Q. 26. How was the material conducted from one vessel to another in the battery of agitation vessels, and how was it conducted from the battery to the spitzkast?

Deposition of Henry L. Sulman.

A. My memory of the battery is that these were connected with one another by fairly broad pipes having regard to the size of each vessel and the end pipe was bent upwards and then downwards and discharged the contents of the last vessel onto a small tray or open launder which communicated with the first spitzkast or spitzlutte.

Q. 27. Was the connection between the last agitating vessel of the battery and the spitzkast substantially similar to that illustrated in Figure 1 of the U. S. patent 835,120, the patent in suit?

A. It was so substantially in design, although this diagram appears to somewhat emphasize the height and the length of the pipe H. For the purposes of the illustration the spitzkast shown is placed in the reversed direction to the flow of the current through the battery. My memory of this apparatus is that the spitzkast was placed in the same line of flow and that there was a comparatively short length of pipe H.

Q. 28. During the operation of this apparatus was an up-current of water maintained in the several spitzkasten?

A. At first this was so for the purpose of separating the gangue into heavier and lighter sands and slimes, for which purpose a small up-current was introduced into the spitzlutte at the bottom in order to suitably classify the gangue products as described. Subsequently the spitzlutte were replaced by spitzkasten where no up-current was used.

Q. 29. Do you remember whether this apparatus

was built and operated before you applied for United States patent No. 835,120 in suit?

A. That I cannot positively say, but I should think it very probable. This answer only refers to the pointed box portion of the patent in suit, as the battery of agitation vessels was already installed and had been working in connection with the Cattermole process.

Q. 30. Have you any knowledge as to whether an apparatus such as you have just described was ever put to practical use, as distinguished from use for a laboratory demonstration?

A. That I have no positive knowledge of; I can only say that I think it is most likely that such apparatus was used first of all in Australia, as a very efficient froth formation and separation was obtained by us in precisely this type of apparatus in Aldermanbury and the first apparatus for giving effect to this in Australia were, I believe, based upon it.

Q. 31. You have no personal or positive knowledge, then, I assume, as to whether apparatus of the type you have described was ever used in Australia or elsewhere for practical purposes as distinguished from a laboratory experiment. Am I correct in this?

A. You are correct, as my work and those who were associated with me in this matter was mainly confined to investigation and experiment in London.

Q. 32. When you for the first time saw a process operated according to the United States patent 835,120 in suit, who was present and who actually conducted the operation?

Deposition of Henry L. Sulman.

A. Mr. Ballot was present and was supervising the experiment which was being performed by Mr. A. H. Higgins, who was working under our joint direction.

Q. 33. What led to your presence and that of Mr. Ballot upon this occasion?

A. At some date a week or two prior to our discovery of the air agitation froth, Mr. Ballot, Mr. Picard and myself had been in close consultation as to a number of factors which we considered required finally investigating and quantifying. They concerned mainly the operation of the Cattermole process, but also had in view the clearing up of a number of loose-end observations noticed in previous developments of oil concentration work. Mr. Ballot, Mr. Picard and myself found it necessary to draw up a schedule of such factors as we considered required investigation, and we instructed the experimental staff at Aldermanbury to carry these out; the carrying out of ~~the~~ these final investigations was done under the immediate supervision of one or other of us throughout the whole of them. The factors to be investigated were as follows. In a report dated March 3, 1905, made by Sulman & Picard and addressed to John Ballot is recorded the work which the whole three of us were doing then and this report is not so much for the information of Mr. John Ballot as the putting on record of work which he and we had jointly done, for purposes of reference afterwards. In it we say on page 2:

"We are in full agreement with the rest of Mr. Higgins' observations and may summarize the

work now being done at Aldermanbury Avenue as the determination of the following factors:—

"1. Influence of acidity on granulation.

"2. Influence of temperature on ditto.

"3. Influence of speed of gabbet agitation on granulation.

"4. Influence of ratio of ore to liquor on granulation.

"5. Influence of metallic salts on granulation.

"6. Influence of the size of particles and of the influence of slimes on granulation.

"7. Influence of the amount of oil on granulation.

"The above factors are being determined on

(*a*) Oleic acid.

(*b*) Residuum oils.

"Mr. Higgins' present report is therefore the first instalment of the above scheme of trials."

Mr. Higgins was sending in in like fashion to Mr. Ballot the daily records of these trials proceeding under the joint supervision of the three of us. It was in the carrying out of the latter factor, namely, the amount of oil in its effect upon granulation that in reducing the amount used beyond all previous quantities in regard to the mineral, that we found granulation to decrease or even cease when a certain limit was reached and that coincidentally a mineral froth began to take its place. When we decreased the amount of oil to about .6 per cent. upon the ore, granulation had ceased to appear and a very considerable proportion of mineral was

found to float to the surface as a thick froth. We still further decreased the amount of oil until we found that with .2 to .1 per cent. of oil on the ore practically the whole of the mineral came to the surface as a thick blackish matted froth.

At the request of counsel for the complainants the Commissioner marks for identification the document referred to by the witness in his last answer as "Sulman and Picard Report March, 3, 1905."

Q. 34. Can you remember at this date the substance of Mr. Higgins' report which you refer to in the document idetnified as "Sulman and Picard Report March 3, 1905," or if you can, will you produce that report?

A. This report has been handed to me by counsel and before referring to it I will state that at this date the discovery of the agitation froth had not been made. Mr. Higgins' report therefore deals with some of the prior factors of granulation set out by us in our schedule of items to be investigated. Mr. Higgins' report is dated March 2, 1905, and is headed "Report on the Conditions of Granulation." It deals in detail with the results of (1) the influence of acidity in granulation, (2) upon the influence of heat on granulation, setting forth in detail the experiments which he tried under the directions he received (3) with the influence of the thickness of the pulp and (4) with the influence of peripheral velocity of cone. On the last page of his report he notes that experiments are also to be carried

out on the influence of the quantity of oil present in order to complete the information regarding granulation.

At the request of counsel for the complainants the Commissioner marks for identification the document referred to by witness in his last answer as "Higgins' Report March 2, 1905."

Q. 35. Do you remember whether Mr. Higgins made any report setting forth the result of his investigation of the seventh topic named by you, namely, the influence of the amount of oil on granulation?

A. Mr. Higgins submitted a record of the experiments he carried out in the investigation which was set him by us in regard to the influence of the amount of oil on granulation. This report or record of Mr. Higgins' followed the usual course of such reports and was sent in a day or two after the facts had been noticed by us. This report is now handed to me by counsel and bears date March 16, 1905. It is headed "Further Report on the Conditions of Granulation" and under the next heading "Influence of the Percentage of Oil" Mr. Higgins describes the formation of the float froth.

At the request of counsel for the complainants the Commissioner marks for identification the document referred to by the witness in his last answer as "Higgins' Report March 16, 1905."

Q. 36. As I understand you, to put the matter brief-

Deposition of Henry L. Sulman.

ly, Mr. Higgins was instructed to ascertain the effect upon granulation of varying the various factors of the Cattermole process and that while carrying out these instructions he found that with the quantity of oil too small to properly granulate the concentrates, flotation resulted. Is this the correct understanding?

A. Mr. Higgins was a capable experimenter fully qualified to carry out intelligently all instructions given to him. The instructions given in regard to each of the factors was that they were to be investigated to their full limit in order to quantify and also to explore the limits of application of the Cattermole process. These experiments were carried out by him in the constant presence, although not the continuous presence, of all of the patentees, Mr. Ballot, Mr. Picard and myself, and he recorded the result of such experiments.

Q. 37. Do you mean that while Mr. Higgins was conducting his laboratory work either you, Mr. Picard or Mr. Ballot or more than one of you together were present watching him?

A. I do mean that, although we were not present the whole of the time. Mr. Ballot had his office business to attend to and Picard and myself were also carrying out other investigations on the oil process at our laboratory. Aldermanbury Avenue is situated about 5 minutes' walk from both these offices and one or other of us were constantly making journeys backwards and forward to Aldermanbury Avenue to see for ourselves the progress which the investigations were making and which Mr. Higgins was fully competent to carry out

on instructions received even when we were not present.

Q. 38. I take it from your last answer that while you, Mr. Picard and Mr. Ballot made occasional visits to the laboratory where Mr. ~~Picard~~ Higgins was working that Mr. Higgins was alone more or less of the time while conducting his work?

A. He may, and probably was, alone for some periods, so far as Mr. Ballot, Mr. Picard and I were concerned, but others of the experimental staff of Minerals Separation were also present at Aldermanbury Avenue, carrying on other researches which had been set them by ourselves at the same time. Minerals Separation had several capable assistant experimenters, all of whom, or nearly all of whom, had been trained by us in oil concentration work and experiment, and whom we could rely upon to diligently carry out our instructions without supervising them every minute of the time.

Q. 39. Did some of these other members of the staff help Mr. Higgins in the investigation of the seven subjects referred to by you in Sulman and Picard's report of March 3, 1905?

A. My memory is that the other experimenters were engaged on the work other than the seven points mentioned which had been set for Mr. Higgins to investigate, by us.

Q. 40. Were either yourself, Mr. Picard or Mr. Ballot present at the time Mr. Higgins first experimented in pursuance of the instructions set forth at the bottom of page 2 of the Report of March 3, 1905,

Deposition of Henry L. Sulman.

with an amount of oil falling within the limits designated in United States patent 835,120 in suit?

A. Mr. Picard and I were not present at the first discovery that by dropping the oil quantity below the last granulation limit the agitation froth was produced, but I have reason to believe that Mr. Ballot was present, as he came 'round to my office, and at once called me to go with him to see what had been the result of such oil diminution, and I went with him at once. The experiment was again carried out in my presence. I understood that it had been found to occur only a comparatively short time before I was called to see the result of the carrying out of this No. 7 instruction to its further limit.

Q. 41. I take it that this was not the first information you had ever had to the effect that froth flotation could be secured by the use of a very minute quantity of oil; am I right in this?

A. In regard to the formation of a froth of this nature, which is so specific in its character and in the presence of an amount of oil so relatively exceedingly minute as in this instance, this was the first time that I had had experience of any such phenomenon. You have used the word "froth" as if this were a term widely applicable to float material produced at a liquor surface, but it has a very wide and loose use, and is frequently very misleading. If by "froth" is meant an assemblage of bubbles at a liquor surface, such bubbles being separated from each other by a contaminated liquor film, the majority of such froths would be use-

less for any purpose of separating mineral from gangue. Thus, we may have a soap froth which will carry but little mineral or gangue, and will differentiate between neither, we may have a saponine froth which will hold neither mineral nor gangue, and many other froths of the same nature. I have heard the float material produced by the Froment reaction described as a froth, but it is a tender and evanescent assemblage of bubbles of carbon dioxide carrying mineral, and is not comparable in nature or character with the agitation froth described in the patent in suit. For a froth to be effective at ordinary ranges of temperature between, say, air temperature and well below boiling, the froth must be coherent and permanent for a considerable time. Such froths are typified in my experience only by the agitation froths produced by vigorously agitating an ore pulp with very minute amount of oil, that is to say, less than one per cent. on the ore in the presence of air. Therefore, in answer to your question, this was the first occasion upon which I had seen a heavy, thick, matted froth, which was permanent and coherent, produced.

Q. 42. Can you form any idea at this date as to how long a period of time elapsed after Mr. Ballot called your attention to Mr. Higgins' operations under the seventh instruction referred to in the Report of March 3rd, 1905, and the construction and operation of the apparatus which you have described as being substantially similar to that illustrated in Figure 1 of the drawing of the United States patent 835,120 in suit?

Deposition of Henry L. Sulman.

A. My memory is that the development of the agitation froth process, and in regard to apparatus to give effect thereto, was proceeded with, with dispatch and interest. If my memory serves, Mr. Higgins for a short time thereafter was engaged in finishing the investigation of one or two factors still outstanding, and my memory further is that others of Minerals Separation staff, among them Mr. Leechman, were occupied in getting together the agitation froth apparatus and experimental plant. This must have occurred in the week or two immediately following the discovery of what happened when oil was employed in quantities quite insufficient to granulate the minerals in the pulp.

Q. 43. Referring to your answer to question 17, do you find anything in the Froment patent regarding agitation in two stages; I refer particularly to the example of his process described in lines 33 to 42 of the complete specification?

A. I do not find the two stages of agitation mentioned in the example of Froment put to me, but I was interpreting the specification intelligently and according to the knowledge of any one who had had previous experience in oil concentration work. I think it will be evident that the example quoted would be best carried out if precautions had been taken to bring the mineral into efficient contact with the oil before liberating a gas within the mixture.

Adjourned to Wednesday, August 7th, 1912, at 10:30 A. M., at the same place.

Deposition of Henry L. Sulman.

London, August 7th, 1912.

Met pursuant to adjournment. Present, counsel as before.

Direct examination of Henry Livingstone Sulman continued:

Q. 44. In the operations which you referred to in your answers to Questions 6 to 8, these operations having been originated by yourself and Mr. Picard, what kind of an apparatus did you use?

A. The apparatus we used was of laboratory type in all cases, that is to say, the vessels of various shapes were of glass, and the tubes and connections were of glass or India rubber; cylinders, beakers, bottles, basins, plaques and so on. In one or two instances small adjuncts were made of tin or tinned iron.

Q. 45. Will you describe, as nearly as you can now remember, the part of the apparatus used for mixing the oil and mineral?

A. So far as my memory serves me, several types of mixing were employed. In some cases the mineral was pre-oiled in agitation apparatus of the cone-gabbet type, in other cases by vigorous hand stirring or by shaking in bottles. In other cases the mineral was not pre-oiled, but the oil was blown in by air, sometimes aided by steam, either as sprays in the case of non-volatile oils, or as vapor, in the case of the more volatile hydrocarbons. I remember that scent-spray bottles were used, and several arrangements of induction pipes for atomizing purposes.

Deposition of Henry L. Sulman.

Q. 46. What degree of success did you meet with in operating this process with the apparatus you describe?

A. Our success in these operations was of very imperfect nature, and our specification rather represented a pious hope that we should ultimately attain success on these lines. The floats obtained were in general thin and tender, and were mainly of the nature of surface-tension effects at a water surface. We tried a great many experiments on various lines indicated, but in no case were we able to attain to a persistent and coherent froth. After a considerable amount of time and experiments we discontinued our efforts in this direction, owing to the small degree of success experienced and from the apparent improbability of such processes developing into a commercial method for mineral separation from gangue.

Q. 47. About what quantity of oil relative to ore did you use in these operations?

A. So far as I remember, the quantities used of oily matter were always substantial, that is to say, they would always be in excess of one per cent. upon the ore taken. At that time we had no knowledge of the effective use of quantities of oil below the proportions employed by Cattermole, and regarded these Cattermole quantities as being likely to be required in flotation work of the nature we were experimenting upon.

Q. 48. Is the apparatus which you have described as being used in these experiments of substantially the nature shown in Figures 1 and 2 of the drawings of

Deposition of Henry L. Sulman.

Sulman and Picard's U. S. patent 793,808, and are you the H. L. Sulman to whom that patent was granted?

A. I am the Henry L. Sulman, one of the grantees of this patent, and the apparatus shown in all three figures reproduces, diagrammatically, essential features in apparatus experimentally employed by us, although in none of the three cases are the diagrams shown exactly those of apparatus employed by us. The diagrams were prepared by us in consultation with our patent agent, and gave rather more precise expression to the type of experimental apparatus we had used in our laboratory. I may mention that our patent agent, Mr. Ballantyne, attended at our laboratory and saw many of these experiments in order to aid us in the drawing of the diagrams referred to in this specification.

Q. 49. You have described an apparatus substantially like that shown in Figure 1 of the patent in suit, No. 835,120, as having been constructed and operated. Will you state whether you built any other apparatus, at a later date, for the purpose of operating the process of patent 835,120?

A. The apparatus shown in the diagram of the patent in suit closely represents that which we jointly designed, and which was built at Aldermanbury avenue for the agitation-froth process. I gave expression to this point design in a drawing of about May 3rd, 1905 (witness produces Report dated May 3rd, 1905, and drawing). This drawing confirms the description I

gave of the plant in my answer to question 27. This apparatus was built, under our supervision, by Minerals Separation staff, at Aldermanbury avenue, and was subsequently modified in some details. I made the drawing produced myself. I, personally, built no other apparatus, but was cognizant of the modifications of the plant referred to. So far as my memory serves me, these modifications resulted in eliminating the aeration table for the treatment of the coarse sands, and I think it was not very long thereafter before the up-currents to the pointed boxes were dispensed with.

Q. 50. Did you see any other apparatus for operating the process of the patent in suit at the laboratory at Aldermanbury avenue?

A. My memory on this point is insufficient, so far as Aldermanbury avenue is concerned. Messrs. Minerals Separation afterwards took other works at Cowper street, and later at Charlotte street, London, E. C., in which further types of apparatus were built and operated.

> At the request of counsel for complainants, the Commissioner marks for identification the Report and drawing produced by the witness in his answer to Q. 49 as "Sulman and Picard Report, May 3, 1905,' and "Sulman Drawing Accompanying Report May 3, 1905."

Q. 51. What was the next apparatus for the purpose of practicing this process which you saw, and under whose direction was it constructed?

Deposition of Henry L. Sulman.

A. Apart from Figure 2 of the drawing in the patent in suit, as to which I have not answered, my memory of the next type of plant is that it had a series of square wooden boxes for the agitation vessels, in place of the cylindrical glass vessels with baffles, which we had used hitherto. This plant was constructed by Minerals Separation staff, under our supervision, at one of the works subsequently taken after the Aldermanbury avenue experiments.

Q. 52. Do you remember where the laboratory was located in which the square box machine was built?

A. I have no definite memory of the locality. I recall that Minerals Separation for a while had a third works for experimental operations at Phipp street, London, but I cannot say at which of these works the square boxes were first erected.

Q. 53. Will you please name in chronological order the different laboratories in which work was carried on for the purpose of demonstrating the process of the patent in suit?

A. Subject to correction, I think the order was our own laboratory in London Wall, where from 1902 until March, 1904, all the experimental work in connection with oil concentration processes was carried out; even subsequent to this date a considerable volume of research work was always proceeding on these matters at our laboratory. The first experimental works taken by Minerals Separation was at Aldermanbury avenue, and thereafter, subject to correction, I think the order of the other works was Phipp street, Cowper

Deposition of Henry L. Sulman.

street, Charlotte street, and, finally, Kings John's Court, Great Eastern street, all in London, E. C.

Q. 54. In the use of the apparatus, represented substantially in the patent in suit, and shown in the sketch identified as "Sulman Drawing Accompanying Report May 3, 1905," which apparatus, I understand, was operated in the Aldermanbury avenue laboratory, what was the purpose of classifying the gangue material by means of the three spitzkast or spitzlutte shown?

A. The object of the classification of the gangue in the compound spitzlutte, shown in the drawing referred to, is set forth in our Report of May 3rd, 1905, wherein it is indicated, that by this means any coarse oiled mineral particles, not caught up and floated off with the froth, may be induced to sink in the first compartment of the spitzlutte, and freed from ~~the~~ fine sands or slimes, with the idea that such oiled mineral might be recovered from the sunken product by passing over the aeration table. At the date of our Report, May 3rd, 1905, we had not fully grasped how dense and coherent the agitation froths were, and having regard to the previous flotation experiences we anticipated that a considerable quantity of the coarser mineral particles would not be held in the froth, and that special steps would be required to deal with this. We shortly found thereafter that such precautions were practically unnecessary, and, as I have stated, they were subsequently discarded. Naturally, the proportions and size of the heavy mineral particles would

be dependent on the mesh of crushing adopted for the particular ore submitted to such a method of separation as described in the patent in suit, and such a mesh was adopted in subsequent operations as would permit practically all the mineral particles being retained by the froth.

Q. 55. Can you remember, at this date, about how long you continued the use (by "you" I intend to include Minerals Separation or the parties in interest) of the apparatus shown in the drawing accompanying Report of May 3, 1905?

A. My memory does not serve me accurately, although my impression is that the period was a comparatively short one. The various members of Messrs. Minerals Separation staff were actively engaged, under supervision, in developing the mechanical details of the apparatus, indicated in the drawing, and progress, in taking advantage of the specific characters of the froth, was rapid.

Q. 56. Was more than one apparatus constructed following substantially the drawing accompanying Report of May 3, 1905?

A. Several sets of apparatus for continuous work, all closely following the essential principles of the drawing, were constructed, and small test apparatus was also designed by us for the experimental investigation of parcels of ore too small to be employed in the continuous apparatus, and for experimental work in connection with new ores.

Q. 57. As I understand the matter, the first ap-

Deposition of Henry L. Sulman.

paratus following the design shown in Sulman drawing accompanying Report of May 3, 1905, was a small laboratory apparatus. After the construction of this first apparatus, was a comparatively large-size machine, built on the same general design, and if so, about what were the dimensions and capacity of such larger machine?

A. It is difficult to draw a hard and fast line between what is laboratory apparatus and one of commercial or practical utility. The drawing in the patent in suit and the drawing by myself, before referred to, show glass agitation vessels combined with a spitzlutte apparatus which was 2 feet, 6 inches in length. This apparatus was capable of treating a very considerable quantity of ore, and if operated continuously would probably have been able to efficiently deal with perhaps half a ton of ore in twenty-four hours; possibly more. The next apparatus was built of considerably larger capacity, in which plant the glass vessels were replaced by wooden ones, and the capacity for ore treatment again greatly increased. I cannot from memory give the dimensions of this next type of apparatus. Several plants of this nature were built, from time to time, of varying and increasing capacity, details of which, after this lapse of time, I cannot carry in my own memory. There were square boxes for agitation purposes, retaining at first the cone mixer, but afterwards the cone agitator of the gabbet type was replaced by cross-shaped agitators with four arms at right angles.

Deposition of Henry L. Sulman.

Q. 58. Can you remember how many of these machines were built following generally the plan of the drawing accompanying Report May 3, 1905?

A. There were several, but I cannot say how many; as after a while subsequent to Aldermanbury avenue works the working of the larger scale plants and their erection passed more specially into the hands of the Minerals Separation staff at these various works, and my own work in connection therewith became of a more consultative nature. Work was also done in Australia, of which I have no personal knowledge.

Q. 59. After Minerals Separation, Limited, moved from Cowper street to Charlotte street, was one of these machines constructed by you or under your supervision?

A. I do not remember that a plant of this nature was constructed under my supervision at Charlotte street.

Q. 60. Did you see such an apparatus constructed at Charlotte street?

A. I did.

Q. 61. Did you see that machine after it was completed, and did you see it operated?

A. I did.

Q. 62. Did you yourself participate in the operation of that machine?

A. No, my memory is that I only saw it whilst it was being worked by the Minerals Separation staff.

Q. 63. Can you give us some idea of the size and capacity of this machine which was constructed at Charlotte street?

Deposition of Henry L. Sulman.

A. No, I am afraid my memory is not sufficiently accurate to give you any details of its size or capacity.

Q. 64. Did this machine constructed at Charlotte street have glass agitating vessels, or of what material were they made?

A. They were made of wood, so far as my memory serves me.

Q. 65. They were larger than the glass agitation vessels first made, were they not?

A. Certainly.

Q. 66. Did the battery of agitating vessels discharge the pulp into a launder or upon an apron, such as designated by the letter O in Figure 1 of the drawing of the patent in suit?

A. My memory is not particularly accurate to give you a definite answer.

Q. 67. Did the machine constructed at Charlotte street have a series of spitzkast or spitzlutte?

A. I believe that there were no compound spitzkast at Charlotte street, that is to say, of the series type for the grading of the gangue into different sizes.

Q. 68. Can you state approximately the capacity of the agitating tanks forming part of the machine built at Charlotte street; by approximately I mean whether the capacity was one gallon, say, or twenty gallons, or a hundred gallons?

A. My memory of the mechanical details and the capacities and dimensions of the Charlotte street plant is now somewhat vague, but the capacity would be certainly greater than one gallon for each agitation box, and considerably less than one hundred gallons.

Q. 69. Was the diameter of these agitating tanks, that is, of each of them, about three or four feet or more?

A. Certainly under three or four feet; much under.

Q. 70. And about what was their height?

A. I do not accurately remember the number or the respective sizes of the agitating vessels which were provided at Charlotte street. My impression is that the size progressively increased, to a certain extent, and the largest may have had agitation boxes two feet or perhaps more in depth.

Q. 71. Did you have anything whatever to do with the designing of this machine which was built at Charlotte street?

A. I was no doubt consulted as to its design, but I do not remember any very specific points in connection therewith.

Q. 72. How did the results secured by the operation of the Charlotte street machine compare with those secured by the use of the apparatus having glass agitating vessels which I understand was the first machine built to operate continuously?

A. Speaking generally, the same high recoveries of mineral were obtained in the large, as in the small, apparatus.

Q. 73. Is the machine which was built at Charlotte street the last one that was built, following the design shown in Sulman drawing accompanying accompanying Report of May 3, 1905?

Deposition of Henry L. Sulman.

A. I do not know that I have stated that the apparatus built at Charlotte street followed with exactness the drawing of the patent in suit or the drawing which I made under date of May, 1905, but it followed this drawing and design in all essentials. Thus, it had a battery of communicating agitating vessels, through which the pulp was passed continuously with high agitation of the pulp in each, the passage of the pulp through these agitation vessels being serial. The agitation vessels were connected with spitzkasten, in which the agitation froth generated, was floated off, whilst gangue was permitted to sink therein. I have stated that in the Charlotte street plant the glass vessels were replaced by square wooden boxes, and that the type of agitator was also changed. As I have stated before in connection with the mechanical expression which was given to the drawing in the patent in suit, at Charlotte street and the other works, my memory is not accurate.

I should say that in essentials all the plants built by Minerals Separation have followed the design given in the patent in suit, subject to such mechanical modification as the practice of the process would naturally lead to on a large scale.

Q. 74. In the operation of the apparatus shown in Sulman drawing accompanying Report May 3, 1905, and in the operation of the subsequent machines of that type which were built up to the time of and including the apparatus built in the laboratory on Charlotte street, was all of the valuable part of the ore re-

covered as a froth, or did more or less of the mineral sometimes float as a film?

A. A froth separation of the valuable mineral was always aimed at and substantially obtained. If film flotation was effected that was an indication that the plant was not being operated to its purpose and best effect, and the plant operations were thereupon adjusted and regulated to give a coherent froth and not a film.

Q. 75. Then, as I understand it, during the operation of these machines more or less mineral did float as a film at times; am I right?

A. No. I do not think you are correct there. Unless the running of the plant were in any way hindered or interfered with, such as by a temporary failure of the ore supply, or at the beginning and the end of the operation, no film flotation was permitted.

Q. 76. When the film flotation was noticed what operations were adjusted and regulated, and in what manner were they adjusted and regulated to give a coherent froth and not a film?

A. Broadly speaking, films would be formed by pulling out the froth produced, by the surface tension effect of a large free water surface on the spitzkasten; therefore, it was necessary to run the agitation portion of the plant to an extent which would produce a froth capable of occupying the free water surface of the spitzkast. Thus, on starting the plant the first portions of froth would be pulled out into a film for a few minutes, and by this means the surface tension of

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the water was reduced. Thereafter the froth piled up and covered the surface of the spitzkasten without further surface tension breakdown. The two adjustments therefore necessary to be made to prevent the destruction of the agitation froth potentially produced at the point where the pulps entered into the spitzkast were to keep the supply of ore up to the capacity of the particular plant, and, secondly, to avoid too rapid a liquor overflow from the spitzkasten. Another point which required observance was that the temperature of the circuit should be maintained at the degree found most suitable for the production of coherent froth with any given ore.

Q. 77. Did the flotation of mineral in the form of a film ever occur at any time other than at the beginning of the operation of the apparatus when the froth was first beginning to spread over the water surface, and at the end of the operation, when the froth was leaving the water surface?

A. In my experience at such times, and also by temporary interference with the other conditions which I have mentioned, such as irregularity in supply of ore or oil, or considerable fluctuations in temperature. Given the proper conditions ascertained in regard to each plant and ore operated upon, a production of a coherent froth was continuous whilst such conditions were maintained.

Q. 78. As I understand your explanation of one of the causes of the appearance of the mineral in the form of a film as distinguished from a froth, this

cause consisted in the fact that when the amount of froth was not sufficient to cover the entire surface of the water, in the spitzkast or spitzlutte, the froth did not have sufficient coherency to maintain itself as a froth, but spread out as a film; am I right?

A. That is so. The surface tension of water is a force of very great magnitude, capable of breaking down liquid and plastic materials into films of great thinness. This is a fact known generally, and it would be the obvious precaution to apportion the spitzkasten surface to the requirements of the float material yielded by any given ore.

Q. 79. In what way was the oil added during the operations with the apparatus which we have been discussing?

A. Two methods I recall were used for adding the oil according to the size of the plant operated. In small scale apparatus the quantities of oil were relatively so small that if these were added drop by drop, intermittencies of oil supply might well occur, and due regulation of such small quantities was difficult. In such cases a solution of soap, that is to say, oleate of soda, was employed, and this solution, containing the oil in a more dilute condition, was capable of closer regulation and quantification. The soap solution on falling into the acid liquor of the mixer was immediately decomposed into very finely disseminated globules of oil and efficiently oiled the mineral without risk of intermittency of oiling. In the larger scale apparatus the oil was added directly either by drops or in

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a very thin stream, as the proportion of mineral present was sufficient to engage all the oil, as, and when added. The oil was added in the first of the series of mixers to the pulp containing the ore.

Q. 80. Following the operation of the apparatus made at Charlotte street, in what kind of an apparatus did you next see tests of the process of patent 835,120 in suit?

A. I have no distinct memory of the details or size of the various plants built and operated at Charlotte street. I was consulting metallurgist to Messrs. Minerals Separation, Limited, and my time was very largely occupied in further research into oil processes on their behalf. My time was not exclusively retained by Minerals Separation, Limited, and I have and had a large private professional practice to attend to. The mechanical details of the various plants were left largely in the hands of Minerals Separation, Limited, and my services were only required now and again upon any special matters which might arise.

Q. 81. Have you any recollection of seeing an apparatus constructed by Minerals Separation after the plans of an apparatus operated by the Sulphide Corporation in Australia?

A. I was not personally cognizant of the work done in Australia, beyond knowing that Minerals Separation were in constant communication with their own staff in Australia, and I believe, with the officials of the Sulphide Corporation. No doubt I was told by Mr. Ballot of the work which was done in Australia,

and I have no doubt that I saw apparatus constructed by Minerals Separation after plans or apparatus operated by the Sulphide Corporation, but I have no recollection of any specific details thereof.

Q. 82. Do you remember of having seen drawings or a description of the plant of the Sulphide Corporation, that is, the Minerals Separation plant in Australia?

A. It is possible that I saw drawings and heard the description of such plant, but I have no memory of this.

Q. 83. Do you remember of receiving any request, at this period of time, to make an endeavor to recover the valuable part of the mineral more fully in the form of a froth, as distinguished from a film?

A. I have no recollection of any such request, my impression being now that at that period the separation was always effectively in the form of a froth, but it is quite possible that the apparatus required adapting to the requirements of an ore in regard to the production of the most coherent froth.

Q. 84. You do remember, then, do you not, the necessity of making some changes in the apparatus at London for the purpose of securing a coherent froth; am I right?

A. About the beginning I think, of 1907, and from that date onwards until the end, I think, of 1910, that is, if I am correct, for a period of about four years, Mr. T. J. Hoover was appointed works manager and engineer for Messrs. Minerals Separation plant, and

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continued to act in that capacity. During this period I had very little to do with the mechanical details of the plant, and, in fact, was not so often present at the works. I am, therefore, not well acquainted with the details of mechanical changes in the apparatus used in London throughout this period, and I understand that the question asked would fall within this period.

Q. 85. Prior to the engagement of Mr. T. J. Hoover as engineer, do you remember the necessity of making changes in the apparatus at London for the purpose of securing a coherent froth?

A. My memory of the froths produced is that they were always coherent when produced, and that it was only necessary to prevent their being broken down by means of the factors, which I have already described. I remember that the tray or launder was gradually dispensed with, but when, and over what period it disappeared, I have no distinct recollection.

Q. 86. Did the idea of dispensing with the tray or launder originate with you and Mr. Picard and Mr. Ballot?

A. That I have no distinct recollection of, though it was doubtless discussed between us.

Q. 87. Was the tray or launder dispensed with before or after Mr. T. J. Hoover was appointed works manager and engineer for Messrs. Minerals Separation, Ltd.? In this connection I assume that the tray or launder referred to by you is that designated by the letter O in Figure 1 of patent 835,120 in suit, and designated by the word launder in Sulman drawing accompanying report May 3, 1905?

A. That I am unable to say. I have no recollection of the period at which it was discarded.

Q. 88. What was the reason the tray or launder was dispensed with?

A. I should think for the purpose of making the plant more compact and for diminshing the free water surface.

Q. 89. What was the purpose in using the launder or apron in the first place?

A. Merely, I think, to convey the sufficiently agitated pulp to the surface of the spitzkasten. There is no apparent reason why the spitzkasten should not have been placed fully against the end of the outlet pipe. Possibly, also at that time, when we were under the impression that coarse oiled particles might not be caught in the froth, we wished to bring them in contact with air and float them initially by skin flotation or surface tension effect, and thus get them caught up in the froth. As I have pointed out, this was a difficulty which we subsequently found not to occur to any appreciable extent, but no doubt the launder persisted in the general type of the apparatus long after its fancied use had become unnecessary. As usual in plants of such nature, compactness was constantly sought after. We were aware before the date of the patent in suit, that coarse oiled particles could be floated by surface tension effect at the water surface if they were brought previously into contact with air.

Q. 90. You have referred to the presence of air in

the Elmore process. It is a fact, is it not, that in the Elmore process an amount of mineral was floated in excess of that which could have been floated by the buoyancy of the oil alone?

A. I have seen it stated that in the Elmore process an amount of mineral could be floated in excess of that due to the buoyancy of the oil alone, but my experience of that process is that the mineral floated was amply accounted for by oil buoyancy, having regard to the amounts of mineral and the mass of oil in which they were carried. It is, however, a fact that the Elmore separated oil and mineral did usually contain a few small bubbles of air and also small globules of water. These could be seen when a layer of the separated oil was spread out in a thin layer upon a white plate. In examining these films it was obvious to me that the small air bubbles were in no case attached to the mineral, but were held suspended in the mass of the viscous oil used.

Q. 91. Have you been continously acting in a professional capacity for Minerals Separation, Limited, up to the present time?

A. I think, without intermission, since the beginning of 1905. Also for a period before that time, with about six months interregnum.

Q. 92. In conducting the operations with the different machines for demonstrating the process of patent 835,120, and particularly in the supplying of oil thereto, as set forth in your answer to question 79, what means did you adopt for the purpose of adjusting the

quantity of oil to an amount equal to a fraction of one per cent. on the ore?

A. In continuously acting plant the rate of feed of the ore was known and the amount of oil requisite to give a fraction of one per cent. upon the ore was calculated; the oil was contained in a reservoir above the first agitation mixer, which reservoir was provided with an accurately ground tap; this was then turned and the number of oil drops necessary to give a certain volume in a graduated measure temporarily placed beneath it, was counted. When the number of drops was in accordance with the amount of ore to give the required proportion, the tap was left turned to that extent, the graduated measure was withdrawn, and the ore supply and liquor started. In smaller demonstration froth plant, such as the bottle or slide machine, the oil was added in the requisite number of drops by means of a pipette or dripping tube.

Q. 93. What measures were adopted in the continuous machine for feeding the ore at a constant rate?

A. Mechanical types of ore feed were adopted, such as are well known in practice, such as the belt conveyor, combined with a hopper, whose discharge apex nearly touched the belt; at a given speed of travel of the belt a uniform quantity of ore was delivered to the mixer, provided the hopper was kept filled, and this amount could be determined with fair accuracy.

Q. 94. Will you describe, in detail, the complete operation as performed in a bottle, as referred to by you in your answer to question 92?

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A. A weighed amount of powdered ore crushed to suitable fineness was mixed in a bottle with about four times its weight of water. Sulphuric acid was added until the pulp had definite acidity, such acidity being below one per cent. of the pulp. The requisite quantity of oil, namely, a fraction of one per cent. upon the ore, was then added by means of a pipette. Sufficient space was left in the bottle to include a substantial amount of air or free space above the pulp level. The contents of the bottle were then warmed by immersion in a warm water bath until a temperature of about 40° Centigrade was reached. The bottle was then closed by a tightly fitting cork and the contents shaken for some minutes with considerable violence by hand. The agitation was stopped, when on placing the bottle upright and keeping it stationary a thick froth of mineral rose to the surface, when the sands that sank to the bottom of the vessel were visually deemed to be sufficiently depleted of mineral, and when the gangue slimes, still in suspension in the liquor, showed by their color or whiteness that the slimed mineral had also been removed into the froth. Different degrees and times of agitation would be necessary with different ores and with varying oils. The temperature might also be varied and the amount of acid necessary to produce sensible acidity would also vary with the nature of the ore constituents.

The removal of the froth from the bottle was not so easy a matter, quantitatively. It could be done to some extent by floating off the froth by addition of water

through a funnel, but special types of apparatus were evolved by us to ensure a better collection of the froth.

Q. 95. What characteristic of the ore constituents would necessitate varying the amount of acid to produce sensible acidity?

A. Any substance present in the ore which would combine with sulphuric acid, such as metallic or alkaline earth oxides, hydrates, carbonates, or, in fact, any substance decomposed by highly dilute sulphuric acid.

Q. 96. In other words, if I understand you, in order to produce the necessary sensible acidity it would be necessary to add enough acid to react with the substances you have mentioned in order that some free acid might remain; am I right?

A. Certainly, with acid of that dilution.

Q. 97. Do you remember who took up the question with your patent solicitors of making application for U. S. patent 835,120 in suit, whether yourself, Mr. Ballot, Mr. Picard, or whom?

A. I think we all three of us saw Mr. Ballantyne on the matter.

Q. 98. Did you ever see an apparatus in the laboratory or works of Minerals Separation in which there were a series of spitzkast or spitzlutte, the first having the pulp delivered to it over an apron or launder leading from the agitator, the first spitzkast delivering froth or float material of some kind over its upper edge and delivering ore still containing some valuable mineral from its lower point upon an apron leading into the second spitzkast, and so on through a series of

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three or four spitzkast. Such an apparatus was described in an article in the Engineering and Mining Journal, dated April 30th, 1910?

A. I do not recollect such an apparatus.

The Commissioner notes that a copy of the article referred to was handed to the witness.

Q. 99. Was the copy of Mr. Higgins' report, referred to in Sulman and Picard's report of March 3, 1905, accompanied by a letter from Mr. Ballot?

A. There would be no necessity for a covering letter, as we were seeing Mr. Ballot daily, and he may have handed me the report personally, but from the opening sentence of our report I acknowledge the receipt of this copy with curve diagrams, which makes it possible that it was sent around to my office by hand, with a covering letter. Mr. Ballot always required us to acknowledge receipt of documents, but I have no recollection of any covering letter.

Q. 100. Were the seven instructions summarized in Sulman and Picard's Report of March 3rd, 1905, conveyed to Mr. Higgins in writing?

A. Yes, in this manner: Mr. Ballot, Mr. Picard and I had several consultations shortly prior to this time, and jointly determined upon the list of factors to be investigated. These were written out by myself in consultation, and in the presence of Mr. Ballot, and, I think, Mr. Picard, and were handed to Mr. Higgins either by myself or Mr. Ballot.

Q. 101. Can you produce these instructions which were given to Mr. Higgins?

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A. No, I cannot.

Q. 102. Have you a copy of them?

A. No, I have no copy.

Q. 103. Where were you and Mr. Ballot and Mr. Picard when this consultation took place?

A. My memory is that it was at our offices at 44 London Wall.

Q. 104. You are not sure whether Mr. Picard was present or not?

A. I know Mr. Picard was present at the consultation when the factors to be investigated were mutually agreed by all three of us. I am not sure whether he was present when these were written out by myself.

Q. 105. Have you ever seen any flotation concentration process, whether an oil process or not, in actual commercial use, as distinguished from demonstrations, tests and experiments?

A. I do not recall having seen any flotation concentration process in actual commercial use, if this means witnessing the running of a plant—at a mine, but I have seen large scale runs made in commercial size apparatus at Minerals Separation works and in the Elmore oil buoyancy plant.

Q. 106. It is a fact, is it not, that in actual mill operations at a mine or any place where ore is being practically concentrated, the rate of flow of the ore-containing pulp varies from time to time, and that the ratio between the water and ore in the pulp is also a varying factor?

A. That is so to a certain extent; the variations

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would to some extent be accidental, as in all concentration processes it is necessary for their best work that uniformity of conditions should be observed and precautions, in all well regulated plants, are taken to secure such uniformity.

Q. 107. In operating with the process which patent 835,120 in suit purports to set forth, did you devise any means for maintaining the amount of acid and oil relative to ore set forth in that patent when operating upon the pulp flowing at a varying rate, and containing a varying percentage of ore to water?

A. In the plant devised to give effect to the process described in the patent in suit at the experimental works of Minerals Separation, there were no difficulties in obtaining uniformity of pulp, of ore supply, and, therefore, of ratio of ore to liquor. In these cases, owing to the fact of the location of plant in London, the ore was dry crushed, and hence could be measured with fair accuracy and proportioned to water in such a manner as to insure uniformity.

Q. 108. You never had an opportunity, then, I assume, for attempting to apply the process under ordinary operating conditions where the rate of flow of pulp varies from time to time, and where the ratio of ore to water in the pulp also varies from time to time, and often, as I understand, with quite great irregularity?

A. Personally I have had no occasion to apply this oil concentration process to conditions that you have named, but it does not occur to me from my experience in cyaniding on a large scale, that there would be any

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difficulty in applying well known types of apparatus to insure such uniformity of condition as is necessary.

Adjourned to Thursday, August 8th, 1912, at 10:30 A. M., at the same place.

LONDON, August 8th, 1912.

Met pursuant to adjournment. Present, counsel as before.

Direct examination of Henry Livingstone Sulman continued:

Q. 109. Referring to your references to the launder or tray, corresponding to that indicated by the letter O, in the patent in suit, will you state whether the process operated to produce a better froth when the launder was used, or in the latter apparatus in which the launder was dispensed with?

A. I could not definitely say, for this reason: The launder was practically a continuation of the flow of liquor from the last agitator to the still surface of the spitzkast. The liquor flowing down it was therefore in motion, and no froth could form there, the necessity for the formation of a froth being a comparatively quiet water surface or mass, which the froth can rise through without interruption. No froth formed, that I can remember, in the launder, but it built up on the surface of the spitzkast as close to the launder as the flow of liquor permitted. We obtained good froths on the spitzkast in this way of the type that was termed by us a mat froth or a cauliflower froth, amounting in

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thickness to one or two inches. Sometimes, to my memory, even more. The surface of our spitzkasten was rather large at first, and by diminishing this area we found we could pile the froth up to a greater thickness. The gradual elimination of the tray or launder was contemporaneous with a restriction of the spitzkasten surface. In the latter types of froth separators, which embodied both these factors, we certainly did obtain a thicker piled up froth, but it is difficult to say how far this was due to the elimination of the tray or launder, or to the restriction of the spitz surface. As I mentioned yesterday, one object of the launder was to give the coarse oiled mineral particles in the pulp which might not be caught in the froth initially a chance of floating at the water surface contemporaneously with the formation of the froth in the spitz box.

Q. 110. Will you kindly, for the purpose of making our terminology clear, distinguish between what I think has been referred to by us as "froth flotation" and "film flotation"?

A. We have generally confined ourselves in speaking of froth to the specific type of froth produced by the process described in the patent in suit. This froth consists of an assemblage of bubbles of air, with some traces, perhaps, of other gases, but mainly air, the bubbles being of varying sizes from exceedingly minute ones to quite large bubbles. The liquor surfaces of these bubbles are highly contaminated and associated with the slightly oiled mineral. The mineral particles are of all sizes, from the finest slime mineral up to

particles of sensible size, say, 60 mesh, sometimes even coarser. The slime mineral particles appear to be closely associated with each other and with the larger particles, at times, in the form of spongy flocks, the whole mineral being so intermixed, as regards its varying sized particles and flocks and with the air bubbles, as to form coherent froth of somewhat spongy nature. The nature of the froth varies somewhat with different minerals, but all have the same specific matted, coherent and persistent characters when the plant and process are operated to their best purpose and effect. The froth so obtained when broken down by mechanical means or by draining results in a deposit of the mineral particles, which exhibit to the touch and upon inspection no visible traces of oil, and one would not suspect the presence of oil therein unless an analysis were made. One essential for such a froth is the inclusion therein of slime mineral, as without the aid of such fine material our experience is that the specific agitation froth we obtain normally cannot be formed.

Q. 111. In the prosecution of the applications for patents in various countries upon the subject-matter of the United States patent 835,120 in suit, were you and Mr. Picard and Mr. Ballot all consulted regarding the various steps necessary from time to time; I mean, as obstacles or objections arose, as they might have arisen, to the grant of such patents, were you and Mr. Picard and Mr. Ballot consulted as to the responses to be made to the various Patent Offices?

A. Doubtless we were all three in close consultation

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with our patent agents in all these matters from first to last.

Q. 112. Do you remember of having been consulted in regard to the prosecution of an application for a German patent upon this subject-matter?

> BY MR. WILLIAMS: Objection is made to any reference to an application for letters patent in Germany, as wholly irrelevant to any of the issues in this controversy.

A. I have a broad memory that we were consulted on all matters in connection with grants or objections to grants of patents in various countries, and I have a memory that some such consultations took place in reference to the German grant, but I should require to refresh my memory before I could recall any details of this.

Q. 113. Regarding the prosecution of this application for a German patent upon the subject-matter of the United States patent in suit, is your memory clear upon the ultimate issue of that prosecution, namely, as to whether such a patent was finally obtained and permitted to remain in force?

> BY MR. WILLIAMS: In view of the fact that the matter referred to is utterly irrelevant to the issues of ~~the~~ this suit, and is further a matter of public record, as to which the documents will speak for themselves, the witness is directed to confine his answer to an affirmation or denial as to whether or not he remembers the matter inquired of in the question.

A. I really don't remember.

Q. 114. Do you mean, by this answer, that you distinctly affirm that you do not remember whether or not a German patent was granted upon the subject of the United States patent here in suit, and that you do not remember whether or not such a patent, if granted, was permitted by the German Patent Office or court to remain in force?

By Mr. Williams: Same instructions.

A. I do not remember that a German patent was granted to us.

Q. 115. Do you remember that a German patent was not granted upon the subject-matter of the United States patent here in suit?

By Mr. Williams: Same instructions, it being noted that the objection is included in the instructions.

A. This is now my impression and belief.

Q. 116. Do you remember that application was made for a German patent upon the subject-matter of the United States patent here in suit?

A. I do.

Q. 117. In carrying out the process which the United States patent in suit purports to disclose, is it necessary in operating upon a flowing pulp, having an irregular rate of flow, and carrying a varying amount of ore, and possibly carrying ores of varying degrees of richness, that some means should be adopted for

controlling the feed of oil to the pulp whereby the operator, conducting the process, might assure himself that at all times he was feeding the percentage of oil to ore prescribed in the patent in suit?

A. Naturally, under non-uniform conditions, means should be adopted for controlling the regulation of any of the ingredients, whether oil or acid, in order to obtaind the desired effect, that is, the production of an agitation froth.

Q. 118. Would it be necessary to make the adjustment of the quantity of oil relative to ore quantitatively, that is, by the use of measuring or regulation feed devices whereby the operator might be assured of maintaining the proper quantitative ratio between the different ingredients, that is, the percentage ratio set forth in the patent?

A. Naturally, and this is the reason why the reservoirs containing the various ingredients necessary are furnished with taps to regulate the additions to the ore, as specified in the patent in suit. Obviously the first essential towards carrying out the instructions as to the proportions given in the patent is that one should know the quantity of ore being delivered to the concentration plant. If these ore supplies are irregular, from external causes, over which the operators of the concentration plant have no control, the necessary regulations would have been determined as to the amount of ore sent to the concentration plant. The same broad requirements would apply to any system of concentration, whether by oil or the ordinary water concentra-

tion methods, and, indeed, to any continuously acting process where a certain range of conditions is necessary.

Q. 119. As I understand you, to state it briefily, the operator of the process, in order to maintain the proportions of oil and acid to ore, as set forth in the patent in suit, naturally must be informed as to the amount of ore, which he is treating, in order to maintain the proportions referred to; am I right?

A. It is, of course, well that he should be informed of this, or should take such steps himself as would enable him to apply the agitation froth process described in suit, under these or any similar abnormal conditions. The adjustment of the oil, even under such abnormal conditions, is, however, very easily effected, because the phenomenon of the agitation froth production is in itself an indication of the right amount of oil to employ. If, therefore, it were not convenient to quantify the ore supply from time to time, it would be quite easy and effective to slightly vary the oil addition to the incoming pulps in order to produce the maximum agitation froth formation. This method of regulating the oil supply we might call a synthetic mode of regulation as compared with the more analytic method of adding known quantities of oil to a previous quantified cr supply.

Q. 120. Then, it might be, that an operator followoing what you have termed the synthetic mode of regulation might not know whether he was adding oil or acid within the proportions set forth in the patent in suit?

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A. It might be so, for the space of a minute or two; as to the acidity, this can be determined instantly by means of Litmus paper, or other suitable indicator, it only being necessary to have a slight degree of acidity present in the pulp. As to oil, the proportions specified in the patent do not need extremely fine adjustment. When the generally minute quantities of oil to ore are considered, which amount in practice, roughly, to about two pounds per ton of ore in a great number of cases, or perhaps somewhat less or more, conditions of ore supply may fluctuate to some extent without greatly affecting the result. If these fluctuations in supply are excessive then the operator would naturally make such further slight adjustment of his oil addition as would meet the altered circumstances.

Q. 121. You have stated that the amount of oil used in this process approximates two pounds to a ton of ore. Can you make a similar approximation regarding the amount of acid?

A. No. This will be determined for each particular ore and run of ore by experiment. Thus, ores which contain calcite will require more acid than ores which contain none, and rough approximation would be made experimentally upon an average sample of the particular ore in question. Thereafter, the rough quantity having been determined the pulp will be regulated as to a sufficiency of acid by Litmus paper or some such means.

Q. 122. I invite your attention to the drawing of United States patent 787,814 granted to J. D. Wolf on April 18, 1905, and inquire whether you ever used an

agitating or mixing apparatus similar to that shown at the left hand of that drawing?

By Mr. Williams: Objection is made to any reference to this Wolf patent No. 787,814 as incompetent, for the reason that the patent is not set up in the answer and is irrelevant to any of the issues herein.

A. Yes; I have seen the apparatus to which my attention is drawn and have seen it in operation at Mr. Wolf's works. It was used in connection with an oil buoyancy process wherein thick viscous oils were used to entrap and buoy up mineral particles in the same general manner as the Elmore process. The object of this agitator was to disseminate the thick oil in globules of sensible size through the pulp in order to bring them into contact with and thus to entrap metallic particles in suspension in the water beneath the oil. The globules of oil then rose to the surface with any entrapped mineral by the buoyancy of the oil, and the mixed floating oil, with its entrapped mineral, and water, were then discharged into a pointed box wherein the separation of mineral and oil from sunk gangue was started.

Q. 123. You have stated in answer to question No. 119 that if it were not convenient to quantify the ore supplied from time to time it would be quite easy and effective to slightly vary the oil additions to the incoming pulps in order to produce the maximum agitation froth formation. In operating according to this method the operator would be guided, would he not, by the re-

sults secured rather than by the maintenance of any known quantitative relations between the different materials?

A. That is what I meant, the result to be obtained being the production of the specific agitation froth required.

Q. 124. Can you remember approximately the date when you saw the apparatus shown at the left hand of the drawing of the Wolf patent which I have referred to?

A. My memory is that it would be some time shortly before the date of the application for this patent.

Q. 125. After you learned of the existence of the Froment British patent in August, 1903, did you direct the attention of the gentlemen who were then, or subsequently became associated, in Minerals Separation, Limited, to that patent?

A. I at once drew their attention to the abstract of the Froment patent published in the Journal of the Society of Chemical Industry about that date.

Q. 126. And yourself and these gentlemen were so favorably impressed with the Froment patent, where they not, that they acquired it, and it is now owned by Minerals Separation, Limited, is it not?

A. Answering the latter portion of your question first, the Froment patent rights are now owned by Minerals Separation, Limited. With regard to the first part of your question, Mr. Picard, Mr. Cattermole and I had already been working on these lines, but from the abstract referred to it was evident that in sundry par-

Deposition of Henry L. Sulman.

ticulars Froment had antedated us, and the gentlemen who were interested with us in our previous work and in the Cattermole process decided to acquire the Froment patent.

Q. 127. What was the first occasion, Mr. Sulman, upon which you ever saw the valuable constituent of a mineral floating as a froth upon a freely flowing pulp or suspended upon the surface of the pulp in the form of bubbles?

A. My impression is that it was during the experimental investigation of the Cattermole process in my firm's laboratory. I can no doubt give you approximate dates by referring to some of my firm's reports on the Cattermole process.

Q. 128. I do not care for the exact date, but I assume from your previous testimony that this occurrence was earlier than the year 1905.

A. Certainly. I think it would be between the end of 1902 and the middle of 1903. In this connection the float material noticed was in the shape of Cattermole granules now and again floated by surface tension effect to the top of the upcast separator instead of their normal sinking to the bottom of this separator. This occurrence was by no means a froth. My first memory of anything approaching to a mineral froth was towards the middle of 1903, when carbonic acid gas was chemically generated in a pulp containing mineral oil in the Cattermole proportions.

Q. 129. In your answer to question 22 you have stated that the gabbet apparatus contained suitable

Deposition of Henry L. Sulman.

baffles. What was the function of these baffles?

A. The function of the baffles was to give the agitation, normal to the gabbet apparatus, of which they form an integral part.

Q. 130. Were these baffles used in the operation of the Cattermole granules precipitation process?

A. They were invariably used during the first portion of the Cattermole granulation where it was necessary to agitate the oil and the mineral to the extent required to uniformly coat the mineral particles with oil. They were not used in the second portion of the process referred to, where it was desired to roll these oiled particles into coherent granules.

Q. 131. Would the use of baffles have been inimical to the carrying out of the second stage of the Cattermole process?

A. Yes. They would have prevented the building up of the shot-like granules desired in the Cattermole process.

Q. 132. But as I understand it these baffles assisted the operation of the froth process at all stages?

A. Certainly.

Q. 133. What effect did these baffles produce in the froth process which would not have been secured by the rotation of the cone gabbet in the cylindrical vessel not provided with baffles?

A. They produced the violent agitation and the entraining of air necessary to float mineral as a froth when quantities of oil were used insufficient for granulation.

Q. 134. I assume from the explanation you have given that when a square vessel is used with an agitator provided with radiating arms, the non-circular character of the vessel and irregular form of the rotating body in a measure dispensed with the necessity of independent baffle members?

A. That is so.

Q. 135. In the Cattermole process, that is, in the second stage referred to by you, where the cone gabbets rotated in a cylindrical vessel not provided with baffles, I presume the movement communicated to the liquid and referred to by you as a rolling movement, I think, consisted largely in a mass rotation of the body of liquid in the vessel?

A. That is substantially correct.

Q. 136. Will you describe the kind of action which takes place when the baffles are used, that is, the sort of movement communicated to the liquid?

A. The normally rotating liquor mass is thrown against the baffles, producing eddies and much more agitation of the liquor mass, and of the particles contained in this mass, than when merely rotatory motion was given to the whole. The particles in suspension were changed in relation to one another when hindered by the baffles more than would be the case when they were uniformly rotated in the suspending liquor.

Q. 137. In the presence of baffles in the gabbet agitator I presume the surface of the liquid becomes more broken and turbulent?

A. Quite so.

Deposition of Henry L. Sulman.

Q. 138. Thus promoting the entraining of air?

A. That is so.

Q. 139. In your answer to question 110 you refer to the bubbles composing the froth as containing air and other gases. Will you state what other gases besides air are found in the froth?

A. The other gases besides air which I have referred to as being in very small quantity, and not necessarily present, are carbon dioxide and very occasionally traces of sulphuretted hydrogen. The carbon dioxide is the more common of the two and is met with in agitation froths derived from mineral which may contain no trace of carbonates or materials which would generate carbonic acid in contact with sulphuric acid. The presence of carbonic acid in such cases is accounted for by the oxidation of the minute oil films on the surface of the mineral by means of the air films attached thereto.

Q. 140. I presume in treating ores containing a considerable amount of easily decomposed carbonate there will be a larger amount of carbonic acid gas than in the treatment of ores containing less carbonates? Is that correct?

A. I do not think it necessarily follows to a substantial degree. The agitation operation requires a certain period before the oil is disseminated over the mineral particles and during this time the carbonates, which were decomposable by the dilute acid employed, would have been decomposed and large quantities of air would have been beaten into and out of the mixing

vessel before an opportunity were given for the froth to form. Very considerable proportions, I should think the major proportion, of the carbonic acid so generated would have been eliminated in the mixing vessel. I state this fairly broadly, and I should expect to find rather more carbon dioxide in the froth derived from a mineral containing calcite than from one which did not contain calcite. I should not, however, regard the presence of carbon dioxide in the froth as an essential concomitant but rather as an accidental inclusion therein.

Q. 141. When did you first meet Mr. Hyde, the defendant?

A. I have not had the pleasure of meeting Mr. Hyde before I appeared as a witness in this case.

Q. 142. Do you remember of ever having had any correspondence with Mr. Hyde?

A. I do not remember any correspondence with Mr. Hyde.

Q. 143. You have referred to the fact that you and Mr. Picard were developing or working upon a flotation process at the time you first learned of the existence of the Froment process. Is the process which you and Mr. Picard were then occupied upon, the one set forth in United States patent 793,808 granted to yourself and Mr. Picard July 4, 1905?

A. That is the only flotation patent that Mr. Picard and I worked at alone, but there was another flotation process about the same time in which we were also con-

cerned with Mr. Cattermole, United States patent No. 788,247.

The Commissioner notes that copies of the several documents produced by the witness and marked for identification have been handed to defendant's counsel.

Direct examination closed.

Cross-Examination by Mr. Williams.

X-Q. 144. Please state generally your experience as a metallurgist, including your education and your associations in that art.

A. I am past president of the Institution of Mining and Metallurgy and a fellow of the Institute of Chemistry, Great Britain. I am also a member of the Society of Chemical Industry and of several other technical societies. I received my chemical and metallurgical training at University College, London, where I devoted four years to the study of these subjects. I was awarded the gold and silver medals for practical and theoretical chemistry, respectively, and the bronze medal for fuel and metallurgy. Since leaving college in 1881 I have been engaged exclusively in the practice of the profession of technical chemistry and metallurgy and since about 1891 I have been exclusively engaged in metallurgical work. I have traveled in connection with my metallurgical work in South Africa, Australia, The Malay States, Japan, Canada and the continent of Europe. I have had considerable experience in the

treatment of various ores, gold, silver, copper, lead, zinc, etc., and am well acquainted with the general processes used for extracting these metals from their ores. I am also conversant with methods for concentrating ores and have given particular attention, of late years, to the concentration of ores by means of oil.

X-Q. 145. Exclusive of your inventive and investigating work for Minerals Separation, Limited, one of the complainants, have you been consulted as a metallurgist and have you made inventions relating to metallurgical subjects? If so, please briefly outline this work.

A. I have. I am the co-inventor with Dr. F. L. Teed of the bromo-cyanide process, a modification of the cyanide process, which has been extensively used, and is still being used in Australia for the reduction of refractory gold ores. This process has already successfully treated about 5,000,000 tons of refractory telluride ores in Western Australia and other refractory ores elsewhere. I have also co-operated with Mr. Picard in developing and perfecting his invention for the reduction of refractory zinc-lead ores by what is known as the briquetting process. I am the inventor of a process for treating refractory lead-zinc ores by a wet process with the aid of sulphurous acid. I also invented a method for converting the dry ball-mill into a wet crusher and this invention has been used by Messrs. Krupp of Germany for many years past.

X-Q. 146. By what concerns have you been consulted as to oil concentration processes?

A. I have been consulted in relation to a float gold process, of which I was also the inventor, which was devised for the purpose of avoiding losses of gold as float material by a method of reducing the surface tension of the milling water, and also in regard to the precipitation and coagulation of slime material from milling water by means of a soap solution. This was in 1893 and 1894. I have also been consulted by the inventors of the Robson and Crowder oil process, also by clients in regard to the Elmore oil process, who were investigating the latter, with the object of working it in a British colony. I have also been consulted with regard to the Cattermole, Froment and other processes which are antecedent to the patent in suit as to date, and I am generally cognizant with the details of other oil processes which have been invented of late years, including that of Wolf, by whom also I was consulted.

X-Q. 147. Your attention was directed to an agitating or mixing apparatus shown at the left-hand of the drawing of United States patent to Wolf, No. 787,814, this apparatus being generally designated by the letter B. What can you say additionally as to that mixing apparatus, its origin, and knowledge of it in the metallurgical art?

A. This was a type of apparatus which was well-known at the date of Wolf's patent. It was built and sold by Messrs. Johnson of Stratford, manufacturers of industrial machinery, filter presses, etc.

X-Q. 148. Please briefly describe the construction

and operation of this apparatus which I believe I may term the "Johnson mixer."

A. It is a cylindrical mixing vessel with a hemispherical bottom and contains a central tube rigidly supported by a series of radial arms. Within this tube is a rotating vertical shaft, at the bottom of which are a series of impeller blades. According to the direction of the rotation of this central shaft and impeller, the liquor in the containing vessel would either be forced up in one direction, or the liquor might be drawn down the tube, and expelled at the bottom, returning again over the top of the central tube. The apparatus was designed to produce much the same effect as the apparatus generally known as a gabbet or cone mixer. In this instance the radial arms supporting the inner tube acted as efficient baffles, preventing the undue rotation of the liquid mass as a whole.

X-Q. 149. You have said that this Johnson mixer was well known at the time of the Wolf patent. I note that the patent was issued in April, 1905, upon an application filed in May, 1903. Did you intend to include one or both of these dates in your answer.

A. I intended the earlier date.

X-Q. 150. You have mentioned an apparatus generally known as a gabbet or cone-mixer. Will you please describe this apparatus?

> Mr. Scott: The question is objected to as implying contrary to anything that has been proved in this case that the term "gabbet" is a well-known term or conveys any definite meaning.

Deposition of Henry L. Sulman.

A. The apparatus which is known to me, and generally to metallurgists, as a gabbet or cone-mixer, is that which is described in the British letters patent No. 840 of 1889, granted to Boulton, Haywood, Boulton and Gabbett, and the apparatus is generally known by the name of the last of these inventors. It was an apparatus well known in the industrial world and figured upon the covers of technical journals. It consists of a

and may contain internal baffles. The containing vessel, in which the cone is rotated, producing a centrifugal ejection effect from the larger diameter of the truncated cone, may be either cylindrical or square. If cylindrical, it is suitably fitted with stationary baffles. This type of apparatus was well known to me for many years previous to its application to the Cattermole process and was used by me and in my laboratory for the agitation and aeration of cyanide pulps.

I should say in connection with this apparatus, that the apparatus as a whole, and not merely the rotating cone, is known as the gabbet or cone-mixer.

X-Q. 151. In your answer to Q. 16 you mention a small scale plant which you were instrumental in designing and erecting and which was sent out to Australia, this plant being for the operation of the Cattermole process. Can you produce a photograph of this plant and if so, will you do so?

A. I can, and will.

and operation of this apparatus which I believe I may term the "Johnson mixer."

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P. 1666, L. 11, insert " the central tube and out at the top, so forming a circuit " before " in "

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I should say in connection with this apparatus, that the apparatus as a whole, and not merely the rotating cone, is known as the gabbet or cone-mixer.

X-Q. 151. In your answer to Q. 16 you mention a small scale plant which you were instrumental in designing and erecting and which was sent out to Australia, this plant being for the operation of the Cattermole process. Can you produce a photograph of this plant and if so, will you do so?

A. I can, and will.

The Commissioner marks for identification a photograph produced by the witness in answering the last question as "Photograph Australian Cattermole Plant."

X-Q. 152. I note that upon this photograph there are red ink markings of a descriptive nature. By whom, if you know, was this marking made?

A. These markings are in my own handwriting.

X-Q. 153. Please briefly describe the plant shown in this photograph?

A. The plant consists of a battery of mixers which consist of vessels formed of metal at the bottom and glass at the top. These mixers are arranged in three series, and each is fitted with an internal revolving cone. The top series of four and the second series below of three mixers are gabbet mixers. That is to say, they contain wire baffles which are essential to the cylindrical form of this mixer and are designed to perform the agitation necessary in the first portion of the Cattermole process. The lower mixers contain no baffles and I think Nos. 5 and 6 mixers of the second series do not contain baffles and were therefore not the normal gabbet mixer. It was in the mixers without baffles that the rolling motion was given to the pulp.

X-Q. 154. Please now produce the reports of your firm relating to the plant which you have just described.

A. I now produce these reports dated November 19th, 1903, and March 4th, 1904.

X-Q. 155. By whom are these reports signed, and to whom were they delivered?

A. They are signed by my firm in my handwriting, and they were delivered to Mr. John Ballot.

The Commissioner marks for identification the reports produced by the witness as "Sulman and Picard Report, November ~~10~~ 12, 1903," and "Sulman and Picard Report March 4, 1904," and copies of these reports are handed to defendant's counsel.

X-Q. 156. In the work done by you for Mr. Ballot and those associated with him, first in the Cattermole Ore Concentration Syndicate, Ltd., and afterwards in Minerals Separation, Limited, what was your habit as to making a record of the work done for these concerns?

A. No matter how closely we collaborated and how intimately all the experiments were known to those concerned, Mr. Ballot always insisted upon such results being put into complete form as a record of work done, and this was always carried out by us.

X-Q. 157. Please produce reports of this nature other than those you have heretofore produced, describing them by the respective dates of the reports.

A. I now do so, and describe the reports as dated 25th March, 1903; May 5th, 1903; September 24th, 1903; April 19th, 1904; May 2nd, 1904; May 18th, 1904; 17th February, 1905; 21st February, 1905. As to the report of May 5th, 1903, the document produced

is a copy from our own file, the original report having been mislaid or lost.

> The several documents produced by the witness are marked by the Commissioner for identification each as "Sulman and Picard Report," followed by the date appearing on such report.

X-Q. 158. You have said that the plant shown in "Photograph Australian Cattermole Plant" was sent to Australia. Who, if anyone, went with it to Australia?

A. Mr. George Chapman, to whom a copy of the photograph was handed.

X-Q. 159. You were asked in Q. 49 whether you built any other apparatus than an apparatus substantially like that shown in Figure 1 of the patent in suit, at a later date, for the purpose of operating the process of the patent in suit. Did your answer to that question include small scale or testing apparatus?

A. No, my answer contained no reference to small testing plant or apparatus.

X-Q. 160. Please now describe the several constructions of small scale or testing apparatus, such as that question would call for.

A. In small scale testing work with small quantities of ore it was not practicable to float a froth off from the small testing vessel by means of water with completeness. Mr. Picard and I devised several types of apparatus for separating the froth after it had been formed in small scale experiments more effectively.

Deposition of Henry L. Sulman.

Many types of apparatus were constructed by us, such as vessels provided with a movable septum, either of celluloid or cloth which might be drawn beneath the froth after this had collected at the surface of the liquor and after the gangue material had subsided. These methods answered better, but we found the best method was to cut the froth portion of the pulp from the gangue portion of the pulp by means of sliding the top portion of the vessel away from the bottom portion upon a suitably constructed slide device. The first type of such apparatus which I made at Cowper street was a block of wood divided longtudinally into three cuts; the bottom portion or cut formed the bottom of a series of vessels which were formed by boring a large hole through the two upper cuts. The two surfaces were then greased and fitted together and formed a series of water-tight vessels. The froth-forming pulp was now filled in these vessels and allowed to stand until the froth had fully formed and the gangue had subsided. Upon now pushing or sliding the upper wooden cut or portion of the apparatus, the froth-bearing liquor was sliced off in entirety and was collected in a vessel placed at the side of this device. This rough apparatus answered so well that we devised a glass and metal agitation vessel for performing the same action with accuracy and efficiency. Two or three of such apparatus were constructed by Mr. Picard and I am able to produce the first of these which fulfilled all the necessary requirements.

X-Q. 161. Please produce the apparatus referred to.

Deposition of Henry L. Sulman.

A. I do so. This apparatus was described by us in a report to Mr. John Ballot dated 24th February, 1910, of which I produce a carbon copy of the original from our files. This apparatus was shown by us to Mr. Theodore J. Hoover.

> The Commissioner marks for identification the apparatus produced by the witness as "Sulman and Picard Slide Machine" and the report produced by the witness as "Sulman and Picard Report February 24, 1910."

X-Q. 162. When relatively to the date of this report February 24, 1910, was the apparatus "Sulman and Picard Slide Machine" made?

A. This particular apparatus was made some little while before, and had been tested by us, but others of the same type had been previously made and experimented with and it was not until we got the results that this improved type gave us that we reported the matter to Mr. Ballot. We were engaged, I suppose, together, about two or three months previously constructing apparatus which led to this.

X-Q. 163. Referring now to your answer to Q. 133, please state whether or not you are prepared to say that with an apparatus like the cone mixer or gabbet, but modified by the omission of the stationary baffles, an agitation froth such as you have repeatedly referred to cannot be produced.

A. I am quite unprepared to say this.

Adjourned to Friday, August 9th, 1912, at 10:30 A. M., at the same place.

Deposition of Henry L. Sulman.

LONDON, August 9th, 1912.

Met pursuant to adjournment. Present counsel as before.

Cross-examination of Henry Livingstone Sulman continued.

X-Q. 165. Have you had a search made for any letter such as is referred to in Q. 99, and if so, with what result?

A. I have, and produce two letters dated March 3rd, 1905, and March 6th, 1905, each signed by Mr. A. O. Williams, Secretary of Minerals Separation, Limited.

The Commissioner marks for identification the two letters produced by the witness respectively as "Minerals Separation Letter," followed by the date of each letter.

X-Q. 166. You have produced a number of reports signed by your firm and each one dated. What does the date of each of these reports signify?

A. I dated each report on the day that it was written and it was immediately delivered to Mr. Ballot.

X-Q. 167. In Q. 110 you were asked to define froth flotation and film flotation, and your answer is apparently confined to froth flotation. Please complete that answer by defining film flotation.

A. By film flotation, which is sometimes also referred to by us as skin flotation, is meant the flotation of particles of oiled or unoiled mineral at a water surface by surface tension effect. Such films would con-

tain the mineral particles in a layer, not substantially exceeding one particle thick. Both oiled and unoiled mineral particles form such films, but the films of oiled mineral are much more persistent than films which are composed of unoiled particles. Such films may occasionally contain isolated bubbles coated with, or contaminated by, such mineral particles, but such occasional bubbles would not form a froth.

X-Q. 168. You have said that in a film or skin flotation the particles of mineral are floated at a water surface by surface tension effect. In the phenomenon of agitation froth flotation is, or is not, the phenomenon a surface tension phenomenon?

A. Not in the sense in which I have employed the term in the answer to the last question. In this answer I referred to surface tension effect as that flotation effect which is exhibited at a plain water surface just as a greased needle will float at such a surface. The whole of the phenomena of froth flotation involve physical reactions which might be broadly classed under surface tension phenomena, but I have not used the words "surface tension effect" to refer to these.

X-Q. 169. You have devoted considerable time to studying and experimenting, have you not, in an investigation of the scientific aspect of flotation phenomena?

A. I have.

X-Q. 170. What have you found to be the effect of heat in the specific phenomena of agitation-froth flotation?

Deposition of Henry L. Sulman.

A. The effect of heat is advantageous to the operation of agitation froth production in two main respects. The first of these and perhaps the lesser effect is the decrease of viscosity of the oil with increased temperature by which it is capable of more ready sub-division and dissemination throughout the mineralized pulp. The second effect of increased temperature is the modification of surface tension effect between the water and oiled mineral surface in the direction of a beneficial effect in the attachment of air thereto.

X-Q. 171. What have you found to be the effect of mildly acidifying the water of the pulp in the specific phenomena of agitation froth flotation?

A. Acidified water tends to wet the gangue particles more efficiently than plain water, or water unacidified, and thus prevents the adhesion of oil to such particles to a greater extent than obtained when unacidified water is used.

X-Q. 172. Is this a chemical or a physical phenomenon?

A. It is entirely a physical phenomenon.

X-Q. 173. What did you find to be the result of heat in such processes as the Elmore, to which you have referred, and also the Wolf process?

A. Both of these processes were bulk oil processes which depended upon the buoyancy of the oil for supporting the mineral entrapped in it. Considerable viscosity of the oil was necessary to prevent the heavy mineral from sinking out of the oil mass too rapidly when so entrapped. The Wolf process involved the

use of oil made still more viscous by the use of chloride of sulphur. In both these processes increased temperature led at once to decrease in viscosity and considerably enhanced the tendency of the entrapped mineral to fall out of the bulk of oil in which it had been entrapped.

X-Q. 174. How about the effect of violent agitation in the Wolf and Elmore bulk oil processes?

A. If agitation exceeded a certain moderate limit in regard to either of these methods the oil became emulsified in the pulp and a mass of heterogeneous material might float whilst other portions would sink; no separation of mineral from gangue would be effected, and with violent agitation, the whole mass would form an emulsified product which might be likened to a salad dressing containing ore.

X-Q. 175. In your simile of salad dressing, please particularize as to the kind of salad dressing.

A. It would be a unique one. Somewhat of the mayonnaise variety.

X-Q. 176. I call your attention to Figure 2 of the patent in suit, and ask you whether, or not, in the agitation vessel *a* there shown, an efficient baffle is illustrated?

A. Yes, certainly; it is the stationary baffle marked *a′* in the form of a pipe which would, and did, act efficiently as baffle.

X-Q. 177. In your answer to Q. 108, you speak of well-known types of apparatus to ensure uniformity of

condition as to pulp supply. What well-known types of apparatus did you refer to?

A. I referred to the many known types of slime settlers and pulp thickeners which are extensively used for the purpose of de-watering and settling fine ore suspensions for the purpose of obtaining a uniform thickened ore product.

X-Q. 178. What, in your opinion, is the best means of determining that the agitation froth process of the

question with your patent solicitors of making application for the United States patent in suit. I now ask you the same question as to the making of the application for British patent No. 783 of 1905, filed April 12th, 1905, a copy of which I now show you.

A. I remember that Mr. Ballot, Mr. Picard and myself took up this question with our patent solicitor, with whom we jointly had many interviews. Mr. Ballantyne, a member of the firm of our patent solicitors, attended for this purpose both at our laboratory, at the works laboratory at Aldermanbury Avenue and at Mr. Ballot's office on several occasions.

Cross-examination closed.

Re-Direct Examination by Mr. Scott.

R-D. Q. 180. Do you find that the overflow pipe at *a′*, shown in Figure 2 of the drawing of the patent in

use of oil made still more viscous by the use of chloride of sulphur. In both these processes increased temperature led at once to decrease in viscosity and considerably enhanced the tendency of the entrapped mineral to fall out of the bulk of oil in which it had been entrapped.

X-Q. 174. How about the effect of violent agitation in the Wolf and Elmore bulk oil processes?

P. 1676, after L. 12, insert "was formed in which oil, water, mineral and gangue were contained as a "mush" some of this material"

... other portions would sink; no separation of mineral from gangue would be effected, and with violent agitation, the whole mass would form an emulsified product which might be likened to a salad dressing containing ore.

X-Q. 175. In your simile of salad dressing, please particularize as to the kind of salad dressing.

A. It would be a unique one. Somewhat of the mayonnaise variety.

X-Q. 176. I call your attention to Figure 2 of the patent in suit, and ask you whether, or not, in the agitation vessel *a* there shown, an efficient baffle is illustrated?

A. Yes, certainly; it is the stationary baffle marked *a′* in the form of a pipe which would, and did, act efficiently as baffle.

X-Q. 177. In your answer to Q. 108, you speak of well-known types of apparatus to ensure uniformity of

Deposition of Henry L. Sulman.

condition as to pulp supply. What well-known types of apparatus did you refer to?

A. I referred to the many known types of slime settlers and pulp thickeners which are extensively used for the purpose of de-watering and settling fine ore suspensions for the purpose of obtaining a uniform thickened ore product.

X-Q. 178. What, in your opinion, is the best means of determining that the agitation froth process of the patent in suit is being carried on in a large scale plant?

A. The efficient production or realization of the specific phenomenon of the agitation froth.

X-Q. 179. In Q. 97 you were asked who took up the question with your patent solicitors of making application for the United States patent in suit. I now ask you the same question as to the making of the application for British patent No. 783 of 1905, filed April 12th, 1905, a copy of which I now show you.

A. I remember that Mr. Ballot, Mr. Picard and myself took up this question with our patent solicitor, with whom we jointly had many interviews. Mr. Ballantyne, a member of the firm of our patent solicitors, attended for this purpose both at our laboratory, at the works laboratory at Aldermanbury Avenue and at Mr. Ballot's office on several occasions.

Cross-examination closed.

Re-Direct Examination by Mr. Scott.

R-D. Q. 180. Do you find that the overflow pipe at *a′*, shown in Figure 2 of the drawing of the patent in

Deposition of Henry L. Sulman.

suit, is described in the patent as a baffle, or as having the function of a baffle?

A. It is not so described in the patent in suit, but nevertheless it would have such an effect, as regards the formation of potential froth in the pulp material escaping into the discharge conduit *a′*, so that if this material were directly discharged upon a water surface the agitation froth would form.

R-D. Q. 181. Another effect of heat, which subject you discussed in your answer to cross-question 170, would be to increase the activity of the reaction between the acid used and any carbonates present, would it not?

A. That is so, it would also lead to an increased elimination in similar proportions of such carbonic acid in the mixing apparatus.

R-D. Q. 182. Whenever flotation concentration takes place, in a pulp to which too little oil to float the mineral by the oil buoyancy has been added, and the pulp has been agitated with the result of raising all of the oiled mineral to the surface as a scum or froth, would you assume that air, beaten in by the agitation had caused or assisted the flotation?

A. This is a very wide question, and would apparently include all quantities of oil below the effective bulk ~~[illegible]~~ oil limits down to the proportions of oil used in the patent in suit. All sorts of phenomena would take place according to the amount of oil employed and degree of agitation given. Some oil entrapping mineral with entangled air bubbles might result, and in such

cases the air would aid oil buoyancy effects, just as corks caught in a fishing net might enable the latter to float. According to the extent or deficiency of oil, intermediate phenomena would take place, such as the production of "mushes" or of sunken material, but to the extent that oiled material was floated, entangled air bubbles would naturally help to this extent.

R-D. Q. 183. Assuming that flotation concentration has taken place in a pulp to which an amount of oil, equal to two per cent. by weight of the ore, has been added, and the pulp has been agitated, thus producing the flotation, would it be your opinion that air beaten in by the agitation had caused or materially assisted, in producing such flotation?

A. My experience of such conditions as you have named, and with the degree of agitation that I have been accustomed to give, is that granulation would mainly result, and it is not my experience that effective flotation would ensue if the pulp were then brought to rest.

R-D. Q. 184. Is the degree of agitation, which you have referred to in your last answer, some particular degree or duration of agitation?

A. It is of the necessary degree and duration required to bring such quantity of oil into effective contact with the mineral particles present in the pulp.

R-D. Q. 185. Suppose we assume, as set forth in question 183, that under the conditions there set forth, flotation is produced, contrary to your experience though it may be, then would it be your opinion that

air beaten in by the agitation had caused, or materially assisted as an essential factor in producing the flotation?

A. You are asking me to assume something that I have no experience of, all my experiments in such directions being to the contrary effect, namely, that when a pulp so agitated were brought to rest, sinking of the mineral, and not flotation, would result. Indeed, this amount of oil, in my experience, would generally fall within the Cattermole range, and it is only when the oil falls below one per cent. on the ore, and practically to about .5 per cent. upon the ore in most cases, that flotation by such means takes place.

R-D. Q. 186. Was your visit to Australia, to which you have referred, at a date when the process which the patent in suit purports to set forth, was in operation there?

A. No, it was some years prior to that.

R-D. Q. 187. Did you have anything to do with the practical application and development in Australia of the process which the patent in suit purports to set forth?

A. Very little, if any.

R-D. Q. 188. Will you please state what your professional or business connection with Minerals Separation, Limited, is at present?

A. I am their consulting metallurgist, with Mr. Picard, and am engaged in investigating and researching upon the various scientific points which arise in connection with this, and similar processes, and also in an-

swering or helping in such metallurgical questions as may arise in connection with the process from time to time.

Re-direct examination closed.

Re-Cross Examination by Mr. Williams.

R-X Q. 189. In R-D. Q. 180 you were asked as to the description of the part *a′*, which you have referred to as a baffle. Considering the specification of the patent in suit, without any reference to the apparatus described or shown in the drawings, in your opinion, would a metallurgist at, say, the early part of the year 1905, be sufficiently informed by such description of the process, exclusive of apparatus, to carry out the agitation froth process described in the patent?

A. In my opinion he would be fully informed.

Re-cross examination closed.

Deposition closed.

HENRY L. SULMAN.

Deposition of Hugh F. Kirkpatrick-Picard.

HUGH FITZALIS KIRKPATRICK-PICARD, a witness produced on behalf of defendants, having been duly cautioned and sworn, testifies as follows:

Direct Examination by Mr. Scott.

Q. 1. What is your name, age, residence and occupation?

A. Hugh Fitzalis Kirkpatrick-Picard; age, 41; residence, 298 West End Lane, Hampstead, London, N. W.; I am by profession a consulting metallurgist and assayer, and my place of business is Sulman & Picard, 44 London Wall, London, E. C.

Q. 2. Are you the Hugh Fitzalis Kirkpatrick-Picard named as one of the grantees of the United States letters patent No. 835,120, involved in this suit?

A. I am.

Q. 3. Will you state, Mr. Picard, when you first learned of the use of oil or fatty matter as a means of separating part of the constituents of an ore by flotation?

A. My earliest recollection would be about 1898. I cannot say closer than that, and in that answer I refer to my knowledge of the Elmore buoyancy process.

Q. 4. And when did you first learn of the joint action of oil and a gas concomitantly acting to produce flotation of part of an ore?

A. I learned of its use as an accidental concomitant during our work on the granulation Cattermole process about 1902, wherein some of the granules were occasionally, accidentally, floated by air.

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Q. 5. And when did you learn of the intentional use of oil and a gas to produce flotation of the constituents of an ore?

A. I think that would be in the latter part of 1903 or early in 1904. I know it was some few months time prior to our first ascertaining the existence of the Froment process.

Q. 6. And I presume the intentional use of oil and a gas, to which you refer, is to some extent at least set forth and described in United States patent 793,-808, granted to Mr. Henry L. Sulman and yourself, July 4, 1905, upon an application filed October 5, 1903, copy of which patent you have before you?

A. Yes, and I see by this date that in one of my previous answers I put my knowledge a little too late. I must have first known of the intentional flotation by means of an oil and a gas early in 1903.

Q. 7. After learning of the Froment process, did you try that process?

A. Yes, I tried the Froment process.

Q. 8. Will you describe your trial of that process, your mode of procedure and results?

A. A sample of crushed ore was taken and mixed with a small amount of powdered carbonate of lime, to this was added water, and on the top of the charge a thin layer of oil was placed. The vessel in which the mixture was, was then agitated so as to thoroughly mix the oil with the crushed ore. After the mixing was judged to be complete a quantity of mineral acid was added to the charge and the whole contents of

Deposition of Hugh F. Kirkpatrick-Picard.

the vessel gently stirred, the effect being that the bubbles of carbonic acid gas was generated by the mineral acid on the carbonate attached themselves to the oiled particles of mineral, which, more or less completely rose to the surface of the liquor, leaving the depleted residue at the bottom of the bottle or containing vessel.

Q. 9. In the patent in suit, No. 835,120, in an example of the application of the process the amount of oleic acid used in that instance is specified as from .02 to .5 per cent. on the weight of ore, the latter quantity being twenty-five times the former. How would an operator practicing the process determine between these wide limits what quantity of oil to use?

A. As a matter of fact, both quantities mentioned are so minute in relation to the proportion of ore that it is hardly right to describe the limits as very wide, but the operator would have no difficulty in determining, if there was any marked difference, which was the best quantity to use, by simply noting whether he was obtaining the specific frothing phenomenon which the patent indicates as being that required.

Q. 10. In other words, the ordinary skill of the operator would lead him to the right amount, as I understand it?

A. Yes, I think an operator after studying this specification, and possessing average technical knowledge would have no difficulty in so adjusting the amount as to obtain this specific and very definite form of froth.

Deposition of Hugh F. Kirkpatrick-Picard.

Q. 11. Did you ever try the Froment process proceeding, as directed by Froment in his British patent 12,778, of 1902?

A. Yes, certainly. The only information we had at first was from reading Froment's patent, and our tests were consequently based upon the information contained in the document.

Q. 12. I invite your attention to the passage extending from line 33, beginning with the words, "such for example," to the end of the paragraph, which begins with those words on page 2, and ask whether you ever tried Froment as there directed?

A. I have no doubt that as our experiments were conducted from our reading the specification, that a test of this kind, if not exactly of these quantities, was made. I cannot definitely remember whether exactly these quantities were used in any specific test.

Q. 13. Do you remember the result secured when operating according to Froment's patent referred to?

A. I remember generally that fairly good recoveries of the sulphide minerals were obtained, but I have no figures of any particular test, showing actual recoveries.

Q. 14. When you say that the recoveries were fairly good, do you mean that they were as good as when you operated as stated in your answer to question 8?

A. Yes.

Q. 15. When these trials of the Froment process, referred to in your answer to question 8, were carried out according to Froment's directions in the patent referred to, did you work with Mr. Sulman?

A. Yes, we were working constantly together on these matters.

Q. 16. When did you first see operated or demonstrated the process which patent 835,120 in suit purports to describe?

A. About the first week in March, 1905.

Q. 17. Have you any means of fixing this date other than by your unaided memory?

A. There were certain reports issued by the works where the process was operating, and certain correspondence and reports issued from our office relating to the discovery, and these aid me in fixing the date approximately. I do not think I am more than a fortnight wrong in my date. If so, it would be earlier rather than later.

Q. 18. Who conducted this first demonstration which you saw?

A. One of the works staff of Minerals Separation, named Mr. Howard Higgins. Mr. Higgins was at that time engaged under instructions from Mr. Sulman, Mr. Ballot and myself, in investigating, amongst other things, the influence of the quantity of oil on Cattermole granulation, and it was as a result of repeatedly reducing the quantity of oil that eventually we arrived at the production of the specific, permanent and coherent froth which is referred to in the patent in suit.

Q. 19. These various factors ~~e~~ a ffecting the Cattermole process had been under investigation for quite a long period, had they not?

Deposition of Hugh F. Kirkpatrick-Picard.

A. Investigation was always going on, but this particular investigation was originated by Mr. Sulman, Mr. Ballot and myself, not very long prior to the time that this discovery was made. We did issue a report which gives the list of investigations to be made and the date of that report will indicate how long the investigations were proceeding before we made this actual discovery.

Q. 20. Were you present when what you call the discovery was made?

A. I was not in the works at the actual moment when the first froth was produced, but I certainly saw it within an hour or two of its production. I believe Mr. Ballot, one of the patentees, was present at the moment of its production, and it was Mr. Ballot who, after seeing it, sent for me and Mr. Sulman to inspect it.

Q. 21. Where were you and Mr. Ballot and Mr Sulman when you gave these instructions to Mr. Higgins regarding the subjects to be investigated regarding the Cattermole process?

A. We three were meeting every day for discussions on these matters, and I think the specific instructions referred to were come to at a meeting of us three at our office, 44 London Wall, but I cannot be quite certain that they were not arrived at at a meeting at Mr. Ballot's office. I clearly, however, remember the meeting and the discussion which led to adopting the programme of work to be done.

Q. 22. And about how long do you think this was

before you were told that the discovery referred to was made?

A. The discovery was made in March, 1905, and if I might see the report which we wrote on the subject I think I could fix the date of the instructions. I now see that in the reported dated March 3, 1905, there is a record of the instructions which were being carried out at the time, but it does not fix the time of meeting at which they were determined upon. I thought that some of these reports might have more specifically fixed the time, but apparently they do not. I am not, therefore, able to say how long the experiments had been going on.

Q. 23. Were these instructions given to Mr. Higgins as much as a month or two before the discovery was made?

A. My memory will not serve me, I could not say.

Q. 24. Can you fix the date by memory within a year?

A. Yes, it was certainly a matter of weeks before, and within that year, at least that is my impression.

Q. 25. Now, as a matter of fact, Mr. Higgins had been investigating these various factors, including the amount of oil, acid, agitation, temperature, and so forth, for probably two or three years prior to the period of 1905, had he not?

A. I do not know how long Mr. Higgins had been at work, and I cannot fix the time he began work

upon it. Of course investigation was constantly going on during the developing stages of the Cattermole process, and Mr. Higgins, after he had been trained by us in oil work, took part in these investigations.

Q. 26. Is it your impression that at the time of this meeting between yourself, Mr. Ballot and Mr. Sulman, it was a new idea to investigate how much oil, acid, and what character of agitation should be used in the Cattermole process?

A. My general recollection is that we had been for some time working, more or less in the dark, without understanding the influence of the various factors of the process, and we decided that it would be well to adopt some form of definite line of research, with a view, if possible, of clearing up various points of difficulty in connection with the work.

Q. 27. Do you mean to convey the idea that prior to the meeting between yourself, Mr. Sulman and Mr. Ballot, to which meeting you have referred, the experimentation by the staff of Minerals Separation, including Mr. Higgins, had been more or less desultory and unsystematic, and that you decided to have them systematize their operations?

A. I certainly do not accuse the staff of Minerals Separation of carrying out their work in a desultory manner, because if I did I would be equally accusing myself, who was largely responsible for the work. In developing an entirely new process such as this, one must necessarily for a time come across factors, the meaning of which are not clear, and in the early stages

much of the work must necessarily be of the trial and error description, and to that extent I am prepared to admit a certain amount of desultoriness.

Q. 28. I notice from the documents of your firm and of Minerals Separation, Ltd., which have been shown to us during this proceeding, that the Cattermole process was not a new idea as early as March, 1903, and I see from these reports that experimentation for the purpose of perfecting this Cattermole process was active from a date at least as early as March, 1903, down to the year 1905; that during that period, and during the early part thereof, the various factors of the process were altered in the various experiments. Now, what I want to have you tell us is just what difference was brought about in this experimental work by the instructions which you say were given jointly by Mr. Ballot, Mr. Sulman and yourself to Mr. Higgins, or to other members of the staff?

A. I find that question somewhat difficult to answer. During the earlier stages we had been experimenting largely on different types of plant, on different ores, and it was only after a great deal of that work had been done that the plant appeared to have become somewhat established and systematized, and starting on that assumption it was decided to more systematically than hitherto attack the problem of the influence of these factors in our then fairly well established type of apparatus.

Q. 29. The effect of these instructions, then, as I understand it, was not so much to change the character

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of the work as to make it more systematic; am I right in this?

A. I do not quite understand what you mean by the character of the work.

Q. 30. By the character of the work I mean the nature of the investigations, such as endeavoring to ascertain the most advantageous quantities of acid, oil, possibly dilution of the pulp, character of agitation, temperature and such other factors as would naturally appeal to an operator of the process as being important. With this explanation can you answer the question?

A. I think I can only answer your question by saying that the object of the investigation embodied in the instructions was to give us a better knowledge of the working of our process than we had before and thereby to give us more control over it.

Q. 31. Work for the attainment of that purpose stated as generally-as you state it, had been going, had it not, for over two years prior to the instructions given by yourself, Mr. Sulman and Mr. Ballot?

A. I thought I had dealt with that in a previous answer. True, work of an investigating character had always been going on, but in the early stages we were a much longer way off finality, so far as conducting the operations were concerned, as we had settled on the final type of plant, and probably also on the best oils to use. It was only after much of this, what I have described, as trial and error work was done, that one could hope to systematize the work in a more definite manner than had been possible hitherto.

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Q. 32. And the effect of the instructions to Mr. Higgins was to systematize the work in the more definite manner that you have referred to, was it not?

A. I presume so; that was the object, anyhow.

Q. 33. In what kind of an apparatus was the process of the patent in suit No. 835,120 performed, when you first saw it performed?

A. It was performed in an ordinary gabbet or cone mixing vessel, fitted with usual baffles, such as was employed for the usual Cattermole process.

Q. 34. When you first saw the process it was not so arranged as to operate continuously, I presume?

A. No.

Q. 35. It is desirable, I presume, to perform such a process continuously, is it not?

A. Yes, certainly.

Q. 36. As a commercial proposition, I presume the process would hardly be capable of use unless provided with apparatus for operating it continuously, at least such would be the case unless a very valuable ore were being operated upon?

A. It is, of course, always desirable to make any metallurgical process continuous, if possible, though intermittent processes may be quite commercial in their results, but this process lends itself very readily to continuity.

Q. 37. What was next done in providing an apparatus for this process after its demonstration in the apparatus you have referred to?

A. I think the next step was building and fitting a

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spitzkasten arrangement to receive the agitated material whereby the separation of the froth should take place with deposition of the gangue.

Q. 38. What was the location of the laboratory or shop where you first saw the process operated?

A. Aldermanbury avenue, E. C.

Q. 39. Will you state, as nearly as you can remember, how many different apparatuses, whether large or small, were constructed at the laboratory on Aldermanbury avenue for the application of this process, describing such machines briefly as you go on?

A. I know that in all several plants of various sizes were built, but I am quite unable now to recall the different plants and locate them correctly at the different works occupied by Minerals Separation during their work. I may say, that in 1906, in the early summer, I think, I went abroad, not in connection with this business, and from this time I had very little to do with the practical development of the process.

Q. 40. Were you in touch with the work upon this process up until your departure abroad?

A. Yes, I was.

Q. 41. Then, will you describe, as nearly as you can, the construction and operation of the first machine built and operated after the first demonstration of the process shown to you?

A. I have not much detailed recollection of the plant or plants employed, I only remember generally that gabbet or cone mixers were used, which were in series, which were connected together, and that the

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last of the series discharged through a turned-up pipe and delivered the material onto a short launder, whence it was conveyed to a series of spitz boxes.

Q. 42. These spitz boxes were provided with upward water currents, were they not?

A. I believe they were, in the first instance, but if my memory serves me rightly, their use was soon abandoned, but I cannot speak with certainty on this point.

Q. 43. Do you remember whether you obtained satisfactory concentrates?

A. Yes, we did.

Q. 44. In what form were these concentrates obtained?

A. They were floated off as a thick, coherent, persistent froth, off the end of the last spitz box of the series, where they were collected in some collecting vessel.

Q. 45. Were any of the concentrates obtained in any form, other than the thick coherent froth you refer to?

A. No, not when the plant was working normally and properly.

Q. When the plant was not operating normally and perfectly what happened?

A. You mean specifically with regard to the nature of the concentrates?

Q. 47. Yes.

A. Well, for example, if through any accident the ore feed failed and the oil feed continued, an excess

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of oil would be supplied and some of the mineral would form rather as granules and sink, or occasionally through any blocking of the delivery pipe a little concentrate might escape, or such concentrates as had already just been delivered might be pulled out rather in the form of a film on the spitz box than as froth, but these incidents were quite abnormal, and generally speaking, I am right in saying that the thick coherent froth always resulted.

Q. 48. During the period from 1903 to 1906, when you were in touch with this work, I understand that quite a number of different apparatuses, large and small, relatively, were constructed for the purpose of carrying out this process. What was the purpose of building this succession of different apparatuses?

A. To arrive at that most suitable to carry out the desired object.

Q. 49. Is it your recollection that the later machines were more suitable for that purpose than those first formed, that is, first formed with spitz boxes?

A. Yes, later ones were certainly better in various detail particulars than earlier ones.

Q. 50. In what particulars did the later machines differ from the earlier ones?

A. One difference lay in the adoption of wooden mixing vessels, which was advantageous on the ground of economy. Other alterations consisted in the mechanical details of driving the shafts of the mixing vessels, which in the earlier machines were frequently badly damaged, and another alteration adopted in the latest

types was replacing the cone gabbet agitator by a blade form of agitator. I have no doubt that other detail developments took place, but those are the ones which strike me most. I remember also that there was a different arrangement of the spitzkasten part of the plant. I have recollection of one plant in which two or three spitz boxes were placed underneath each other instead of all being in one tier, and another alteration that I remember was placing the spitzkasten close up to the delivery of the last mixer instead of conducting the pulp through a short launder. That, I think, generally indicates the changes that were made in the various plants.

Q. 51. In the early apparatuses in which the last mixing box delivered the pulp upon a launder or tray, through which, or over which, it flowed, to the spitz box, what was the purpose or function of such a launder or tray as used?

A. I do not recall that it had any particular function, and it was possibly only put in for some structural convenience to connect the two parts of the plant. I am not aware of any appreciable difference in the results, whether such a tray is used or not. The plant is certainly a little more compact without it, and probably that accounts for its disappearance.

Q. 52. During this period of development you are aware of no reason for introducing any change in the first apparatus which you saw, other than the simple desire to make the apapratus more compact, or to simply adapt it to the shape of the space where it was to be placed, or something of that kind?

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A. I cannot recall any particular reason except for improvements in mechanical details. I may say that the process, in my opinion, worked perfectly in the first plant, and therefore, except for mechanical reasons, I can recall nothing which might be held to be an essential alteration in the working of the process.

Q. 53. Do you know whether any plant was ever introduced into actual use, following the design of this first spitz box machine, and whether it was successful?

A. I know that the process was introduced into Australia, but how far the design of the plant in use differed from the early ones, I have no knowledge.

Q. 54. You cannot, then, speak from your own knowledge as to the precise order of steps or proportions of different materials that were used in the process which you have referred to in Australia?

A. No, I have no personal knowledge.

Q. 55. You have never met, nor had any communication, by correspondence or otherwise, with Mr. James M. Hyde, defendant in this case, before today, have you?

A. No, I have not.

Q. 56. Do you remember whether any of the experimentation with the various apparatuses built, after the first spitz box machine, was directed towards obtaining results of the character which you had been informed had been secured in Australia?

A. I believe so, but I have very little knowledge of what took place after the plant was working in Australia. I was engaged at this period mainly on another business.

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Q. 57. Do you remember in what respect it was desired by Minerals Separation, Limited, to duplicate the operation carried on in Australia?

A. My general impression is rather that Australia got its instructions from London than that Australia supplied information to London. Of course, there was a constant interchange of developments on both sides.

Q. 58. You remember, do you not, that there was an effort in the construction and operation of the various machines in London to profit from some of the suggestions received from Australia or to secure results that you were informed had been secured there?

A. No doubt some information of value was obtained from Australia, particularly as to the questions of horse-power required, wear and tear of plant, and on such points as would naturally be best determined on a large scale working plant.

Q. 59. During the period up to 1906, when you went abroad, do you remember of ever having had your efforts directed towards securing as good operation of your experimental machine in London as was being secured by the apparatus in use in Australia?

A. No, I have no recollection on that point.

Q. 60. Have you any personal knowledge as to whether the process of patent 835,120 was in practical use in Australia at all prior to your leaving for abroad?

A. I do not know when the process started to work in Australia.

Adjourned to Saturday, August 10th, 1912, at 10:30 A. M., at the same place.

Deposition of Hugh F. Kirkpatrick-Picard.

LONDON, August 10th, 1912.

Met pursuant to adjournment. Present, counsel as before.

Direct examination of Hugh Fitzalis Kirkpatrick-Picard continued:

Q. 61. I presume the words froth and scum are used synonymously in the patent in suit; are they not?

BY MR. WILLIAMS: Objected to as calling for a construction of the language of the patent, and therefore incompetent.

A. Yes, they are.

Q. 62. I presume in this experimental work which you and Mr. Sulman were engaged in in connection with Minerals Separation, Limited, and the gentlemen connected therewith, you frequently found the flotation effect and the granulation and precipitation of mineral to appear simultaneously?

A. In your question do you refer to our work on the froth flotation process or to our work on the Cattermole granulation process?

Q. 63. You may limit your answer to your work on the Cattermole granulation process.

A. Yes. In working the Cattermole granulation process we certainly found that some of the mineral in the form of granules tended to float though the great bulk of the mineral was recovered in the form of sunk granules. The small amount of floating mineral obtained in this process was a source of trouble to us.

Q. 64. In operating the process, which the patent in suit purports to describe, was it your invariable custom to establish a quantitative relation between the amount of oil and the amount of ore, or did you sometimes proceed simply by using such a quantity of oil as would produce the result you desired, without knowing just the quantitative relation of that amount?

A. In all our tests we endeavored to maintain an approximately definite relationship as to quantity between the amount of ore and the amount of fuel fed into the plant.

Q. 65. Did you have anything to do with the practical operation of the process of 835,120, that is, with its introduc~~ean~~tion into actual business use?

A. I had nothing to do with the operation of the plant in Australia, and have never seen it there. I took part in discussions relating to the type of plant which was to be used in Australia, but that is my only connection with it.

Q. 66. Have you any personal knowledge as to whether the procedure set forth in the patent in suit and the apparatus there illustrated, ever proved satisfactory and successful in actual concentration in a commercial way as distinguished from laboratory experiments?

A. I have never seen the operation at work on a large scale on a mine anywhere.

Q. 67. Will you state the distinction between the froth or scum which is referred to in the patent in suit, and the floating material resutling from opera-

Deposition of Hugh F. Kirkpatrick-Picard.

tions such as described in United States patent 793,808, granted to yourself and Mr. Sulman on July 4th, 1905, as the result of an application filed October 5, 1903?

A. I have already described the froth produced in the patent in suit as being of a very dense, coherent and thick deposit. The floating concentrate obtained in patent 793,808, on the other hand, was of a very feeble and tender character, the very reverse of coherent and persistent, and was of such a nature that extreme care had to be used in its collection. It never reached any appreciable thickness, and was rather of the nature of a thin film.

Q. 68. To what do you attribute the difference between the condition of the floating material produced in accordance with the process of the patent 793,808 and that produced under the process which patent 835,120 purports to disclose?

A. I attribute the difference largely to the greater quantity of oil that was used in working the patent 793,808. The oiled mineral produced under this patent was more of the Cattermole variety, and in our experience air introduced in the manner shown in Figure 1 does not attach itself very readily to these particles of mineral heavily oiled, and though the air did, to a large extent, carry the mineral flocks to the surface, they, the flocks, seemed to sink again with ease in such a manner as to suggest that the air which caused them to float had freed itself from the particles.

Q. 69. Was an apparatus such as shown in Figure 1 of patent 793,808 built and operated?

A. Yes, something very similar to this. I do not recall an apparatus similar to Figure 2, but I have a definite recollection of something of the nature of Figure 3 having been tried.

Q. 70. I take it, then, that you attribute the defective action which you have referred to in the operation of the apparatus of Figure 1 of 793,808, to the use of too much oil?

A. Yes, I think that in large measure accounted for the relative non-success of this process, but on the other hand, I do not think success would have been obtained with this particular apparatus, even though the quantity of oil had been much reduced.

Q. 71. From which I infer that it is your idea that the success of a froth flotation process of this kind is dependent, not only upon the use of the proper quantity of oil, but also upon the use of mechanism adapted to bring about other conditions equally necessary to the production of a froth?

A. Of course suitable apparatus must be employed to carry out the object set forth in the patent specification, and we show one method by which these objects may be obtained, but no doubt other forms of appliance would effectively carry out the intention of the patent which is essentially the production of the dense persistent and coherent froth which is the peculiar attribute and essential feature of this invention.

Q. 72. You refer to this froth as dense, coherent and thick; is the process of patent 835,120 limited to a froth which is dense, coherent and thick, as disting-

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uished from some other kind of a froth which you have had experience of?

By Mr. Williams: Objected to as calling for a construction of the scope of the invention covered by the patent in suit, and therefore incompetent.

By Mr. Scott: Question withdrawn.

Q. 73. You have referred to the froth produced by the process which the patent in suit purports to set forth as dense, coherent and thick. Does that process in practice result in producing a froth which is distinguished from other froths which you have seen produced in these characteristics of density, coherency and thickness?

A. According to my experience, the characteristics of this froth are essentially different from any other kind of mineral froth that I have seen produced.

Q. 74. Are these characteristics so essentially different that observation of a froth enables you to state whether it has been produced by the process which patent 835,120 purports to set forth, or by some other process?

A. I do not think I should have any difficulty in distinguishing between the froth obtained by the patent in suit and that produced by any other means known to me.

Q. 75. Could you distinguish, by observation, that is, by visual observation, between froths produced by

Deposition of Hugh F. Kirkpatrick-Picard.

the use of five-tenths of one per cent. one per cent. one and a half per cent. and two per cent., respectively, of oil?

A. I should have no difficulty, I think, in distinguishing the five-tenths per cent. froth from the two per cent. and probably from the one and a half per cent., but I do not know what is the absolute limit in quantity which would render it difficult for me to distinguish between them. I may state that by using the upper limit of two per cent. in the apparatus described in the patent in suit I should expect to find an appreciable quantity of granules formed, and this would aid me in forming an opinion as to the amount of oil used.

Q. 76. Do you remember about when Mr. A. Howard Higgins entered the employ of Minerals Separation, Limited?

A. My recollection of it was that in December, 1903, he entered our employ, and that in June, 1904, he joined the Minerals Separation staff.

Q. 77. In carrying out the process which the patent in suit purports to disclose, is there anything distinctive about the mode of agitation of the oiled pulp as compared with the agitation used in applying the Cattermole process, wherein the purpose is to granulate and precipitate the valuable mineral?

A. In actual fact the same apparatus was employed for both purposes during my connection with the experimental work on the two processes. In the patent in suit it is more essential to beat in air, which is not an important point, and rather to be avoided, in the

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Cattermole process, where the object was only to mix the various ingredients, air not being one of them.

Q. 78. In operating the apparatus of the patent in suit as shown in Figure 1 of the drawings, does the material come out of the pipe H in the form of a froth, or did the froth form upon the apron or tray O, or did it rise from the body of the liquid in the spitz boxes, or did it collect in some other way which does not occur to me?

A. I should say that the froth was present, so to speak, potentially in the pipe H, that is to say, if the gabbet agitator had been stopped, froth would at once have risen to the surface of the liquid in the gabbet; the charge, therefore, in passing through the pipe H was in condition to form froth at the earliest moment that it had an opportunity to do so. My impression is that the actual froth did not form until the pulp reached the spitz box, but it is quite possible that some froth began to form on the tray O.

Q. 79. You have referred to having been called in to witness the operation of forming a froth according to the process which the patent in suit purports to set forth shortly after the discovery of such a mode of procedure was made. Will you state just what you saw on this occasion that was new to you; that is, what was it you regarded as a discovery?

A. What struck me as being new was seeing practically the whole of the mineral which was in the ore charge floating on the top of the liquid in the gabbet whilst at rest, whereas hitherto when using larger

quantities of oil I should expect, and, indeed, would have seen the mineral in a more or less granulated condition through the charge, and not floating on the surface, except as to certain accidental flocks. The difference was most marked, and created a very distinct and decided impression on my mind.

Q. 80. I presume that you and your associates proceeded to investigate the causes which had produced this result, and if so, what were the causes to which you attributed it?

A. We already knew from the first test that the cause was due to reducing the quantity of oil much below that hitherto employed, and observation of the froth clearly indicated that the air which had been beaten in played an important and essential part in the production of this new phenomenon. I presume that further investigation work was carried on, but in my opinion, the invention may be said to have been complete after that first operation.

Q. 81. At the time the process which the patent in suit purports to set forth was first exhibited to you, I take it that you were not then for the first time made cognizant of the possibility of using so small a quantity of oil as had been used, or that you then first became cognizant of the utility of beating air into the pulp; am I right in this?

A. I had no idea prior to this, that by reducing the quantity of oil to the limits which were used in this experiment that such a result would be obtained. I, of course, knew that air would float mineral, previously

oiled, but it was not anticipated by me hitherto that this particular result would be obtained if air were beaten in, in the manner in which it was done in making this test. The result of the operation as a whole was an entire revelation to me, and though I knew that work was being carried out on the reduction of the quantity of oil, I never for one moment anticipated in my mind, as being likely to occur, what in fact actually did occur.

Direct examination closed.

Cross-Examination by Mr. Williams.

X-Q. 82. In Q. 11, you were asked if you ever tried the Froment process as directed by Froment in his British patent 12,778, of 1902, and in Q. 12 your attention was called to a particular passage in the Froment specification, commencing on line 33 of page 2, and you were asked whether you ever tried the Froment process as there directed. Please explain fully your answers to those two questions, supplementing what you have already said by anything further which may be necessary to make your meaning clear.

A. Perhaps the only point that wants elaborating is the order in which I added the various ingredients. I made a large number of tests, and it is possible that in some of them the order may have varied from that which I gave in answer to question 8. What I did was to take the specification and exercise my knowledge of these matters to the best advantage, so as to obtain the best result that the process was capable of. It was

therefore my usual practice to add the acid after the other ingredients as I wished to get the oil well mixed with the ore before destroying the carbonate of lime present, which was necessary to produce carbonic acid gas for the separation of the oiled mineral. That I was right in this procedure is clear, because at a subsequent date Messrs. Minerals Separation received instructions from Froment on how to work his process, and in these instructions he advised the performance of the operation on exactly the lines followed in my experiments. This is clear, not only from written instructions, but also from a drawing which was supplied, in which the mixing without acid is shown in one vessel, and the separation by the addition of acid in a second vessel.

By Mr. Scott: All of the answer beginning with the words "that I was right," and extending to the end of the answer, is objected to as hearsay.

X-Q. 83. Can you, and will you, produce, Froment's description to which you have referred, and also his drawings, to which you have referred?

A. This is the description, and these are the drawings.

The Commissioner notes that the witness produces a document in French, entitled "Description et Instructions pour la concentration des minerais," and a large and small sheet of drawings, and at the request of counsel for complainants, marks the description for identification as "Froment De-

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P. 1709, after L. 2, insert "Drawing," and the small drawing as "Froment"

ings was, or was not, any apparatus received from Froment?

A. Yes, he sent over a small-sized plant to be used in carrying out his process, but I never used this apparatus, because, firstly, I did not consider it by any means a satisfactory appliance to effect the operation, and I was satisfied that only indifferent results could be obtained upon its use. Further, the apparatus was of too large a size for use in our laboratory. It was sent eventually to Minerals Separation Company's works, but I have no knowledge of whether they used it or not. A search for this apparatus has been made ~~for it~~, but I expect it has been destroyed. Certainly it has not been found.

Cross-examination closed.

Re-Direct Examination by Mr. Scott.

R-D. Q. 85. Do you remember whether you carried out the process of the Froment patent before you received the instructions and drawings from Mr. Froment, to which you have referred?

A. Yes, certainly, many tests were made before we reecived the drawings and instructions.

Re-direct examination closed.

Deposition closed.

HUGH F. K. PICARD.

Adjourned to Monday, August 12th, 1912, at 2 o'clock, at the same place

therefore my usual practice to add the [illegible]

gas for the separation of the oiled mineral. That I was right in this procedure is clear, because at a subsequent date Messrs. Minerals Separation received instructions from Froment on how to work his process, and in these instructions he advised the performance of the operation on exactly the lines followed in my experiments. This is clear, not only from written instructions, but also from a drawing which was supplied, in which the mixing without acid is shown in one vessel, and the separation by the addition of acid in a second vessel.

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A. This is the description, and these are the drawings.

The Commissioner notes that the witness produces a document in French, entitled "Description et Instructions pour la concentration des minerais," and a large and small sheet of drawings, and at the request of counsel for complainants, marks the description for identification as "Froment De-

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scription," and the large drawing as "Froment Drawing A."

X-Q. 84. In addition to the description and drawings was, or was not, any apparatus received from Froment?

A. Yes, he sent over a small-sized plant to be used in carrying out his process, but I never used this apparatus, because, firstly, I did not consider it by any means a satisfactory appliance to effect the operation, and I was satisfied that only indifferent results could be obtained upon its use. Further, the apparatus was of too large a size for use in our laboratory. It was sent eventually to Minerals Separation Company's works, but I have no knowledge of whether they used it or not. A search for this apparatus has been made ~~for it~~, but I expect it has been destroyed. Certainly it has not been found.

Cross-examination closed.

Re-Direct Examination by Mr. Scott.

R-D. Q. 85. Do you remember whether you carried out the process of the Froment patent before you received the instructions and drawings from Mr. Froment, to which you have referred?

A. Yes, certainly, many tests were made before we reecived the drawings and instructions.

Re-direct examination closed.

Deposition closed.

Hugh F. K. Picard.

Adjourned to Monday, August 12th, 1912, at 2 o'clock, at the same place

Deposition of John Ballot.

London, August 12th, 1912.

Met pursuant to adjournment. Present, counsel as before.

JOHN BALLOT, a witness produced on behalf of defendant, having been duly cautioned and sworn, testifies as follows:

Direct Examination by Mr. Scott.

Q. 1. What is your name, age, residence and occupation?

A. John Ballot; age, 52; residence, at Hotel Cecil, Strand, London; my occupation is chairman and managing director of Minerals Separation, Limited, and chairman of Minerals Separation American Syndicate, Limited, the two complainants; place of business, 62 London Wall, London, E. C.

Q. 2. Was Mr. Hyde, the defendant, employed directly by Minerals Separation, Limited, or by a syndicate of which Minerals Separation, Limited, was a member?

A. Mr. Hyde was employed by Minerals Separation to carry out the work of the syndicate formed to investigate in Mexico. He was paid directly out of the funds of the syndicate.

Q. 3. Who were the members of the syndicate?

A. The members were Messrs. Lazard Brothers & Co., London; Messrs. Beer, Sondheimer & Co., of Frankfurt, and Minerals Separation, Limited, London.

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Q. 4. Did all three of the members of the syndicate contribute towards the funds of the syndicate?

A. Yes.

Q. 5. You mean that each member of the syndicate, including Minerals Separation, Limited, contributed money to the treasury of the syndicate?

A. I do.

Q. 6. It is averred in the bill of complaint in this suit that the defendant was instructed by the engineers and experts of one of the complainants or both of them in all technical details and particulars as to the letters patent in suit, and the installation and use of the process of ore concentration constituting the invention set forth in said patent. Can you state any particular or specific instructions which were so given to the defendant, Mr. Hyde?

A. Immediately after Mr. Hyde's arrival in London, Mr. T. J. Hoover, who was then our consulting engineer, which practically means that he was the chief engineer of the company, was requested by me to give Mr. Hyde every possible instruction and all information necessary to enable him to acquire the necessary knowledge to equip him for the purpose of the duties which he was destined to undertake and had undertaken to carry out in the Republic of Mexico. I may here mention that I understood from both Mr. Hoover and Mr. Hyde that they had known one another for years, and Mr. Hoover assured me that Mr. Hyde was a fully qualified engineer, to whom the business could be safely entrusted. Mr. Hoover, on my instructions,

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placed at Mr. Hyde's disposal, all the files of patents in our office relating to the Minerals Separation processes, not only the patent in suit, but everything on file at the time. Mr. Hoover also placed at Mr. Hyde's disposal his own reports and notes on the process made during his visit to Australia, as well as comments and notes relating to the patents and processes. After spending some days or probably weeks, I do not know how long, in mastering these details, he was taken to our test works, then at Charlotte street, off Great Eastern street, where he was shown various apparatus, both small scale and large testing plant in use and operation at that time. I personally had discussion with Mr. Hyde before he left for Mexico and asked him whether he had gained all the information that he thought necessary to enable him to carry out the work which he had undertaken, and he gave me his assurance to the effect that he had. I would here mention that before Mr. Hyde arrived in London a special type of machine had been invented or designed by Messrs. Sulman & Picard, known as the slide machine. Messrs. Sulman & Picard communicated the information to Mr. Hoover, Mr. Hoover discussed it with me, and at my request took the matter up to have similar machines built for use in our Charlotte street works. The details of this invention were communicated to Mr. Hyde by Mr. Hoover, and our works manager, Mr. A. C. Howard, together with Mr. Hyde, were entrusted with the building of this by suitable makers. So soon as this machine was built one was placed at the disposal of Mr. Hyde, and he was

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given one of our works operators or experimenters, together to run through a series of tests as quickly as possible to get the handling of the machine and generally to become efficient in the management of it, as it was found to be a very efficient apparatus that would just suit the operations of the testing work with which Mr. Hyde was to be entrusted during his Mexican and other investigations for the purpose of acquiring business for the syndicate. With this machine and with another one subsequently sent to him, Mr. Hyde carried out his tests, not only in Mexico, but also in Canada, where he was requested to go, and did go, early in November of 1910.

By Mr. Scott: That part of the preceding answer which sets forth alleged disclosures made by Mr. Hoover to the witness is objected to as hearsay.

Q. 7. What is the source of your information to the effect that Mr. Hoover placed at Mr. Hyde's disposal all the files of patents in your office?

A. First, I requested him to do so; secondly, he assured me that he had done so; thirdly, besause I saw Mr. Hyde reading them myself.

Q. 8. Does the preceding answer as to your source of information apply also to Mr. Hoover's reports and notes on the process made during Mr. Hoover's visit to Australia, and his notes relating to the patents and processes?

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A. My recollection is yes, with this qualification that when I make use of the word "process" I refer to the patent in suit, which was being applied and worked on a commercial scale, and which, of course, we wished Mr. Hyde to introduce into Mexico.

Q. 9. What was the nature of these reports and notes made by Mr. Hoover during his visit to Australia and his notes relating to the patents and processes?

A. To give a clear answer I should require to refresh my memory by reference to the documents. In general, the notes on his visit to Australia were on the working of the apparatus and the process there in practice. With regard to the patents and processes he had drawn up a memo of their sequence and their various characteristics.

Q. 10. What did Mr. Hoover go to Australia for?

A. Mr. Hoover at that time occupied the position of general manager of Minerals Separation, and the Board thought it advisable to send him to Australia for the purpose of seeing the process worked on a large scale, and also to investigate the operation of a large scale plant previously erected, that is to say, erected previous to Mr. Hoover's joining our company, and operating or treating a dump of tailings purchased by my company, jointly with others, from the Sulphide Corporation, and to report thereon.

Q. 11. I presume you yourself have been in Australia and seen the working of the process in question there?

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A. I have not.

Q. 12. Had any of the members of the Board to which you refer seen the process, to which you refer, in Australia?

A. Yes, only one, Mr. J. H. Curle.

Q. 13. At the period in question, namely, at the time of Mr. Hoover's visit to Australia, was the process being operated commercially anywhere except in Australia, by commercially I mean as distinguished from the testing operations, which I understand were conducted in England or Wales?

A. No, with the exception of the London and Welsh works, it was not operated anywhere, to my knowledge, on a commercial scale. My meaning is, it was worked in Australia.

Q. 14. The operations at London and in Wales were not of a commercial character, were they, that is, were not being conducted in the regular course of mining operations?

A. The London works were purely testing and investigation works. The plant in Wales was erected for the special purpose of producing concentrates from a shipment of several hundred tons of San Francisco Del Oro ore, which that company had sent to England to test out a process of zinc smelting, and this Welsh plant was erected at the works of a small smelter company in Wales with that object, and it produced a tonnage of concentrates from the San Francisco ore for their smelting tests.

Q. 15. What was your purpose in directing Mr.

Hoover to instruct Mr. Hyde as to the practice of this process, and to put in his hands his notes regarding the Australian practice?

A. To give Mr. Hyde as much information as possible of work on a practical scale, as no work on a commercial scale was being done in England, with the exception of the tests in Wales, and that plant also Mr. Hyde was specially requested to visit to gain as much information as he could.

Q. 16. I take it from what you have said, that you yourself have no perosnal knowledge as to how the process in question was carried out in Australia, and that you cannot from your personal knowledge describe that process or the mechanism used for the purpose of putting it into effect; am I right in this?

A. If by personal knowledge you mean personal inspection, you are right. On the other hand, I have naturally had the reports of our engineers and members of the staff who erected the plant and operated it.

Q. 17. Did you yourself direct these engineers to proceed to Australia for the purpose of introducing the process?

A. In the first instance we sent out Mr. Chapman, who had received his instructions, drawn up in consultation with Sulman, Picard and myself.

Q. 18. At what date, as near as you can remember, did you first send any one to Australia for the purpose of introducing the process which the patent in suit purports to describe?

A. We sent out Mr. Chapman, as far as I can re-

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member, early in 1904, probably March, I am not quite sure, with the Cattermole plant. He erected that, operated it, and during the early part of 1905, a hundred-ton plant of the Cattermole type was built at the Sulphide Corporation works, and, I think, was completed and started operation about May, of 1905. That plant operated for a short period, but in the meantime the oleic acid froth or agitation froth process was discovered and information of same sent out to Mr. C. F. Courtney, who was our consulting engineer in Australia at the time. And if my memory serves me rightly, early in July he tested the frothing process in this particular Cattermole plant, and soon after converted the Cattermole plant into a frothing process plant. I find on looking at my letter-press copy book that I wrote Mr. Courtney on the 3rd of March, 1905. I quote from this letter as follows:

"And also to hand you copies of Messrs. Sulman & Picard's report of the 3rd inst. together with Mr. Higgins" of 2nd inst, with two sheets of curves to show the very important results obtained. As the various reports and curves will explain themselves I have but little to add, and I trust that you will be pleased with the result."

Again in my letter to Mr. Courtney of March 10th, 1905, I say:

"I am pleased to tell you that during the week we have made some very important discoveries which will, I think, almost revolutionize our processes by

way of simplifying and cheapening the same. I hope that by next mail the work will be sufficiently far advanced to send you full particulars. Several points have yet to be determined, and the discoveries are of such a nature that we have decided to take our expert and Counsel's opinion thereon with a view to assuring ourselves that we can get good protection under patents. I may mention for your private information that we do not use more than .1 per cent of oleic acid per ton of ore and although we have not assays out that the recoveries will be very satisfactory."

Again in my letter to Mr. Courtney of March 17th, 1905, I say:

"*Higgins Report.* Herewith I enclose you copy of Higgins report as received this morning, being a continuation of the one sent you on the 3rd March. By using one per cent of acid water or even less than that, three of water to one of ore, and adding .1 per cent of oleic acid, and heating the circuit to from 30/32 C and then agitating from 8 to ten minutes in a single gabbet we find that almost as soon as the cone is stopped in the gabbet from 70 to 80 per cent of the contained mineral immediately rises to the surface in the form of a scum or froth which floats persistently and remains on the surface of the water for days at a time. Any heavy mineral that may be present and not carried up with the froth is readily

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separated from the coarse sands by ordinary tabling. This experiment has been repeated again and again. The ore treated was ground to 60 mesh originally but we found that only a very small percentage remained even on 90 mesh the bulk passing through one hundred and fifty. I think this discovery very important indeed, and have no doubt that you will thoroughly test it on your straight ores as well as on your tailings and old slimes, especially the stack of rich slimes on the mine as it will merely need agitation and running off into settling tanks with some mechanical device for skimming off the floated froth or perhaps a large nest of conical upcasts or spitzkasten may be made to do the work and I have no doubt that you will soon solve the mechanical problem for fixing up suitable apparatus.

"As I wrote you in my last, we are having our patents thoroughly overhauled in view of these developments, and it will therefore be necessary to keep this as confidential as possible until we know the result. Even with thirty mesh stock Higgins finds that although not much flotation takes place as only the slime mineral rises to the surface, the coarse mineral is still sufficiently oiled to permit a perfect separation by tabling with air-blast by air-distributor. This factor is important as it reduces the consumption of oleic acid to a vanishing point being only *.1 per cent* per ton of ore treated and that can be very readily washed off the concen-

trates with a weak alkaline solution for the purpose of separation or breaking-down. In the case of copper ore or ores not requiring separation, I take it that it will hardly pay to recover the oleic acid."

The Commissioner at the request of counsel for complainants marks for identification the letterpress copies of the three letters referred to by the witness, respectively, as "Courtney Letter," followed by the date of the letter.

By Mr. Scott: The statement contained in the second sentence of the last preceding answer regarding the erection in Australia of the Cattermole plant is objected to as hearsay, as is also the statement in the following sentence regarding the operation of that plant. Similar objection is made to the statement contained in the fourth sentence to the effect that the Cattermole plant was converted into a frothing process plant.

Q. 19. What was the purpose of having your patents thoroughly overhauled, as set forth in your letter of March 17, 1905?

A. I think just a business precaution.

Q. 20. Why is it that you cautioned Mr. Courtney to keep the information contained in your letter of March 17th, 1905, confidential until you knew the result of the overhauling of your patents?

A. So far as my memory serves me the object of doing so was because at that time Australia was not under the Patent Convention, and if any information had

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leaked out before we had lodged a patent there somebody else might have pirated the idea.

Q. 21. What did this have to do with the overhauling of the patents which you already had?

A. It is an expensive matter to take out patents, and we did not wish to take out patents needlessly if the discovery had already been protected by any of our previous patents.

Q. 22. Who were the members of the Board to whom you refer in your answer to question 10?

A. The members of the Board were Dr. Gregory, Mr. J. H. Curle, Mr. W. W. Webster, Mr. Francis L. Gibbs, myself, and Mr. A. H. Krohn.

Q. 23. How long had these gentlemen been associated with you in the investigation or exploitation of processes of the kind we are discussing?

A. They were all of them associated with me from the registration of Minerals Separation, which I think took place on the 31st December, 1903, except Mr. Francis Gibbs, who joined the Board probably a year later, but I am not certain. Previous to 1903, Mr. Webster, Dr. Gregory and Mr. Curle were associated with me in the Cattermole Syndicate. I think that was registered in September, 1903, but they were also interested in the investigation of the Cattermole process, which was taken up early in 1903. That is, an option was taken up over the Cattermole process and we found the money to investigate that, with an option to acquire it in syndicate form.

Q. 24. Were these other gentlemen whom you have

mentioned actively engaged with you in these enterprises, or did they leave the conduct of affairs entirely to you?

A. I think I may answer without egotism that the conduct of affairs was entirely left to me.

Q. 25. Did these gentlemen confer with you at all regarding the enterprises you have referred to?

A. We had regular Board meetings and met almost daily and discussed matters, except that Mr. Curle was a great traveler and was frequently abroad.

Q. 26. Were these discussions confined to the financial aspect of the enterprises, or did these other gentlemen enter into questions regarding the practical operations in the various laboratories which I understand Minerals Separation and the Cattermole syndicate conducted?

A. We discussed practically everything that concerned or related to the company, although the technical part was almost entirely left to my decision.

Q. 27. Did you consult these other gentlemen regarding the technical matters?

A. Not necessarily consulted them, I discussed it with them, and it was only where heavy financial outlay was concerned that I consulted them.

Q. 28. In your letter of March 3rd, 1905, to Mr. Courtney, you refer to Messrs. Sulman & Picard's report of the 3rd inst., and Mr. Higgins' report of the 2nd inst. Are these the reports of those gentlemen bearing the dates mentioned which have been marked for identification during the examination of witnesses in this suit?

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A. Yes.

Q. 29. I take it that when Mr. Higgins apprised you of the operations set forth in his report of March 16th, 1905, this was not the first occasion upon which you had been informed of the possibility of using minute quantities of oil in mineral flotation operation; am I correct in this?

A. I had seen the work in progress from about the 1st day of March onwards.

Q. 30. When you saw Mr. Higgins' operations about the 1st of March, 1905, that was not the first occasion, was it, upon which you had been informed of the possibility of using minute quantities of oil in mineral flotation processes; by minute I mean quantities within the range set forth in the patent in suit?

A. No, I had never seen it before within the range of the patent in suit.

Q. 31. You kept in close touch, did you not, with the operations of the technical staff of Minerals Separation, Ltd., including the operations of Messrs. Sulman & Picard?

A. Yes, I did.

Q. 32. That is, you kept fully informed as to the investigations conducted by Messrs. Sulman and Picard and by the staff of Minerals Separation, Ltd.?

A. Yes, as fully as I possibly could.

Q. 33. I presume you frequently visited the laboratories conducted at different times by Minerals Separation, Ltd., and consulted frequently with Messrs. Sulman & Picard?

Deposition of John Ballot.

A. Yes, I consulted with Messrs. Sulman & Picard, especially in the earlier years, almost daily, frequently several times a day, and watched operations carried on in their laboratory, and later on Aldermanbury avenue and the other laboratories that we had. But in later years, of course my work had accumulated so much that I had to leave it to other members of the staff, so that I could not pay the frequent daily visits which I was accustomed to pay, perhaps until October, 1906, when Mr. T. J Hoover arrived and took up his duties as general manager.

Q. 34. And when you saw the work in progress from March 1, 1905, onwards, as referred to by you in your answer to question 29, was this the first occasion upon which you had been informed as to the use in an oil flotation process of the intentional beating in of air for the purpose of promoting flotation?

A. The intentional beating in of air to produce or promote the flotation of froth which was developed by that process was certainly not known until the fact had been actually discovered that by using a very small quantity of oil, say .2 or .1 per cent., and agitating it for a certain time, and then leaving the mixture to stand that the whole froth rose to the surface. By "discovered" I mean until the experiments had established the fact that this extraordinary phenomenon was every time reproduced by using the small quantity of oil, violently agitated, and then leaving it to stand, when the mineral rose to the surface in the form of dense froth.

Deposition of John Ballot.

Q. 35. I understand from your last answer that you mean that a discovery was made about March 1st, 1905, and that subsequently the operation was repeated simply to verify the result secured; is this the distinction which you mean to draw between the word "discovered" and the word "established"?

A. The discovery was made about, or soon after, March 1st. And as soon as we had experiments repeated to show that the same phenomenon was constantly reproduced we considered it established and that the principal cause of flotation, or perhaps the entire cause of flotation, was due to air beaten into the pulp, assisted, of course, by the other agents.

Q. 36. What was the result of the thorough overhauling of your patents referred to by you in your letter of March 17th, 1905, to Mr. Courtney?

A. The results were that our patent attorneys very strongly advised us to protect the froth discovery under a patent.

Q. 37. What are the other agents referred to at the close of your answer to question 35?

A. Oil or oleic acid and sulphuric acid.

Q. 38. Did the members of your technical staff, aside from Messrs. Sulman & Picard, ever participate in any of your conferences, or were any suggestions ever made by members of your technical staff?

A. No, I do not think that our members of the staff participated at the conferences between Messrs. Sulman, Picard and myself; while carrying out instructions or experiments, they were naturally always looked

upon as being intelligent people, and were treated as such.

Q. 39. Who were the members of your technical or experimental staff in March, 1905?

A. Apart from Messrs. Sulman and Picard, we had Mr. A. H. Higgins, Mr. John Leechman, and, I think, Mr. A. K. Burn joined us about that time, or towards the end of March.

Q. 40. What were the educational and technical qualifications of these men?

A. I think Mr. Higgins was an associate of the Royal School of Mines, and I think Mr. Leechman was that, too, and had a higher degree, which I do not remember. He is a member of the Institute of Mining and Metallurgy. Mr. Burn, I do not know as to his qualifications. He had his training with Messrs. Sulman and Picard.

Q. 41. In answer to question 37 you mention sulphuric acid as one of the substances included in the term "other agents" appearing in your answer to question 35. In what manner does sulphuric acid contribute to the flotation effect?

A. I believe it keeps the oil from going to the gangue. It also has an effect of settling slime gangue more readily, and by keeping the oil from sticking to the gangue, naturally it assists the mineral in picking up the very minute traces of oil disseminated throughout the mass of agitated pulp.

Q. 42. The patent in suit gives a range of quantity for the oleic acid to be used extending from .02 to .5

Deposition of John Ballot.

per cent. in the example set forth in the paragraph beginning at line 70, page 1, the larger quantity being twenty-five times the magnitude of the smaller. In carrying out this process how is the determination to be made as to which of these widely differing quantities is to be used?

A. Starting with the small quantity, say at the rate of one pound per ton of ore, an operator can soon tell by the appearance as to whether the characteristic froth is produced or not. ~~Guided by appearances he would either increase or decrease the quantity of oil or oleic acid until the cauliflower or characteristic froth is produced or not.~~ Guided by appearances he would either increase or decrease the quantity of oil or oleic acid until the cauliflower or characteristic froth was produced, which in itself will be an unfailing index as to whether or not proper conditions have been attained, and he need only then repeat the measurements quantitatively of oil or oleic acid added to his pulp. Of course I assume that the proper agitation and other factors are satisfactory.

Q. 43. I understand from your answer that the way to carry out the process which the patent purports to set forth, is to operate with varying quantities of oil until what you term the "characteristic froth" appears, and then to keep on operating with the proportion of oil ascertained to have been used in producing such a characteristic froth as you have referred to; am I right in this?

A. In small scale tests the operator would naturally quantify or measure the quantities of oil added, whether they be above one pound per ton or below one pound per ton, and would judge by the appearance of the froth and result when the best proportion had been hit upon.

Q. 44. Would you make a distinction as to the mode of operation upon a commercial scale?

A. On a commercial scale, or before commercial operations are begun, small scale work should, and would invariably, be carried out to determine the best quantities, and the oil supply fed to a commercial plant would be calibrated accordingly, that is, after ascertaining the quantity of ore plus water fed into the plant, the oil feeding apparatus would be set to deliver as nearly as possible the quantities per ton determined by small scale experiments.

Q. 45. In your answer to question 42 and the following questions, I understand that the quantity of oil must be determined experimentally, and that the proper amount of oil is determined by noting the quantity which produces the froth, which you state has certain characteristic qualities. I understand, then, that it is impossible to carry out the process by simply applying the proportions of oil set forth in the patent, and that the final test is not the use of any particular proportion of oil, but the production of the froth; is this correct?

A. The only way to carry out the process is that of applying the proportions of oil set forth in the patent, but to determine, as all practical men will do, which of

Deposition of John Ballot.

the proportions, within the range, yield the best result, the characteristic nature of the froth is always an indicator which will of itself tell an experienced operator when the best conditions have been attained, or having been attained, whether they are maintained in a continuous running, where variations may occur in the feed to the plant of ore and water or pulp.

Adjourned to Tuesday, August 13th, 1912, at 2 o'clock in the afternoon, at the same place.

LONDON, August 13th, 1912.

Met pursuant to adjournment. Present, counsel as before.

Direct examination of John Ballot continued:

Q. 46. Did you personally, Mr. Ballot, impart any instructions to Mr. Hyde as set forth in the bill of complaint herein?

A. Except as to discussing general matters with him, I do not think that I personally gave him definite technical instructions.

Q. 47. Will you state the reason why the instruction of Mr. Hyde in his duties was entrusted to Mr. Hoover and Mr. Higgins and others, rather than to Messrs. Sulman, Picard and yourself?

A. Mr. Hoover was our chief engineer at the time, and had the general management of our testing works. Messrs. Sulman and Picard were more in a consultative position at that time.

Deposition of John Ballot.

Q. 48. Did Minerals Separation, Ltd., ever send Mr. Higgins to Australia?

A. Yes, Mr. Higgins was sent to Australia.

Q. 49. At about what time was he sent to Australia?

A. From the summer of 1908 to the spring of 1909.

Q. 50. Was this slide machine to which you have referred necessary in experimentation for the purpose of applying the process of patent 835,120 in practical operations?

A. It was not necessary, but it was a very convenient form of apparatus.

Q. 51. Before the slide machine was designed by Mr. Sulman or Messrs. Sulman and Picard, as the case may be, did you have other mechanism for making tests of that kind?

A. Yes, we had several, the principal was the ordinary gabbet, in which the process was practically originally discovered, which consisted of a single mixing vessel, with a cone agitator and loose baffles slipped over the sides. The agitator was driven either by a small motor direct coupled to the agitator shaft, or by a belt, and the agitation took place, and after a sufficient amount of agitation had been given to it the cone agitator was stopped, and as soon as the contained pulp and water came to a rest the froth always floated to the surface. After leaving it for some minutes, the gangue settled out and the concentrates were either skimmed off by spooning or they were flowed off by inserting a funnel through the froth some distance into

Deposition of John Ballot.

the water below and pouring in more water, so that the gabbet was filled and the froth permitted to flow over the rim of the gabbet, when the products were collected and assayed. The tailings, that is to say, the residues, were drawn off either by pouring off the water or by emptying the residue through an opening in the bottom of the mixing vessel, when a similar operation was repeated, if necessary, and as often as was necessary.

Q. 52. Was the information which you directed Mr. Hoover to impart to Mr. Hyde, aside from the patent in suit, necessary to enable Mr. Hyde to perform the duties for which he was engaged by the Mexican Syndicate?

A. My instructions to Mr. Hoover were to give Mr. Hyde all the information. It is quite possible that some information given may not have been necessary for carrying out his duties, but I thought it was expedient and perhaps also courteous to let our Mexican representative know as much about the company's processes and inventions as possible. Not only to carry out his work, but to get a personal interest in the company and in his position.

Q. 53. Is the Mexican Syndicate still in existence?

A. No, it was taken over by the American Syndicate.

Q. 54. Can you state the substance of any of the technical details and particulars as to letters patent No. 835,120, regarding which Mr. Hyde was instructed in pursuance of your directions, or otherwise?

Deposition of John Ballot.

A. From personal knowledge, I cannot detail particulars, except that the patent was handed to Mr. Hyde. Mr. Hoover was requested to give him all the information necessary. He was given the run of our works to inform himself. As soon as the slide machine was prepared an experienced operator was placed at his disposal in conjunction with Mr. Hyde, to carry out a series of tests. These tests Mr. Hyde carried out, personally informed me that he did so, and sent in a report of the work that he did.

Q. 55. In order to enable Mr. Hyde to apply the process, which the patent in suit purports to set forth, and in order to enable him to determine whether or not that process would be applicable to any ores which he might encounter in Mexico, was it necessary that he should have any special instruction in technical details and particulars as to the patent in suit?

A. If my memory serves me correctly, the patent itself tells him, or would have told him, that different ores required different treatment, that is to say, that the treatment of each individual ore could easily be determined by a few preliminary experiments on the general lines and within the limits directed by the specification itself.

Q. 56. By this do you mean to convey the idea that no instructions were necessary in addition to those contained in the patent in suit in order to enable Mr. Hyde to perform his duties for the Mexican Syndicate?

A. No, I do not wish to convey that idea, without qualification, but to a gentleman experienced in metal-

Deposition of John Ballot.

lurgical practice, as Mr. Hyde was recommended to me to be, and which I fully believe, but very little additional instruction would be necessary, and although I do not remember definitely that I discussed the details with him, I feel certain that he had all facilities at his disposal in our works, because of his assurance to me before he left for Mexico that he felt himself fully qualified for the work entrusted to him, which naturally involved treating a great variety of different ores.

Q. 57. You say very little instruction, and I assume you mean very little instruction additional to that contained in the patent, would have been necessary to enable Mr. Hyde to perform his duties for the Mexican Syndicate. Will you please specify what this little instruction would have been or was?

A. I do not think any additional instructions were necessary to qualify any one skilled in the art to carry out the process beyond the directions given in the specification, but the little additional instruction necessary in Mr. Hyde's case was to make him proficient as quickly as possible in handling the type of test apparatus which he was to take out, remembering that his time in London was more or less limited, to enable him to acquire the necessary information, before he set out for Mexico.

Q. 58. Then as I understand you, the only effect of instruction given to Mr. Hyde was to impart to him the information which you say is contained in the patent in suit, and to impart that information in pos-

sibly a shorter time than you think he might have secured it from the study of the patent alone without instructions. Is that correct?

By Mr. Williams: Objected to as a misstatement of the witness' testimony.

A. The instructions given to Mr. Hyde embraced all the information we had at our disposal and under my special orders our test works and testing apparatus were placed at his disposal so that it could not possibly have been limited in the form of your question.

Q. 59. Was any of this information which you say was conveyed to Mr. Hyde and was not contained in the patent in suit necessary to enable him to discharge his duties for the Mexican Syndicate?

A. I think I have already answered that question, and I repeat that we felt it necessary for our Mexican representative to have as full a knowledge as possible of the various processes owned by the company.

Q. 60. Mr. Hyde's duties for the Mexican Syndicate consisted in the examination of ores and tailings for the purpose of ascertaining whether or not they were amenable to treatment by the process which the patent in suit purports to set forth, did they not?

A. That constituted part of his duties and of course an essential part.

Q. 61. At the time that you engaged Mr. Hyde for the Mexican Syndicate was it your idea that instructions additional to those contained in the patent in suit were necessary to enable him to perform the duties referred to in question 60 and answer?

Deposition of John Ballot.

A. Apart from that relating to the policy and business of the company I considered it necessary for Mr. Hyde to have a full knowledge of the methods employed in our London works as well as of the apparatus, and to qualify himself in handling such apparatus before he started for Mexico.

Q. 62. Were the apparatus and methods in use at the London testing plant at the time of Mr. Hyde's engagement by the Mexican Syndicate the same as those described and illustrated in the patent in suit?

A. Broadly, yes. In small scale apparatus there was the modification of the slide machine, also an apparatus attempting to carry out the frothing test on a small scale by drawing off the froth continuously. The larger scale plant was modified to the extent of having three or four single spitz boxes connected with the square agitation vessel by means of a tube some three or four inches in diameter passing from agitator box to frothing box, the tailings being lifted from the frothing box by means of a pneumatic pump, that is, a pump operated by means of air under pressure, into the second agitating vessel, and from there onwards the operation was repeated in the same way, the froth from the first and each spitz box overflowing into a launder which carried the total contents to a collecting box or filter bed as the case may be.

Q. 63. Where was the connection between the agitation vessel and the frothing box, at the top or bottom or where?

A. It was practically at the bottom of the agitation

vessel but entered the spitzkast some distance down. I could produce plans if that were called for.

Q. 64. It entered the frothing box below the water surface therein?

A. Yes, some distance below.

Q. 65. Are you sure that the connection between the agitation vessel and the frothing box was a tube and not simply a hole in the wall that separated the agitation vessel from the frothing box?

A. I am quite sure they were tubes.

Q. 66. Did the small scale apparatus and the larger scale plant referred to in your answer to question 62 operate in substantially the same way?

A. Substantially yes, the same characteristic froth was produced, but the chief difference consisted in the one being a continuous plant and the other intermittent.

Q. 67. In your answer to question 62 I think you refer to an apparatus attempting to carry out the frothing test on a small scale by drawing off the froth continuously, and also referred to a larger scale plant. I meant to inquire as to whether the apparatus first mentioned by me in this question operated in substantially the same way as the larger scale plant referred to?

A. If my memory serves me correctly, in carrying out tests with that small scale plant the prepared froth pulp was fed into the spitz somewhat on the same lines as in the larger scale plant and it was also at times fed on to the surface of the water or a little launder leading on to the surface of the water.

Deposition of John Ballot.

Q. 68. Was the small scale continuous plant as efficient in its operation as the larger scale plant?

A. That particular plant was not and it was soon abandoned, and the old style of gabbet agitator and skimming off the froth, or the slide machine, were made use of, and at present the slide machine has in London, at least, superseded other small scale testing plants. By testing I mean experimental plants.

Q. 69. Do you mean that Mr. Hyde saw this small scale apparatus from which it was attempted to draw off the froth continuously?

A. Personally, I do not know.

Q. 70. I would like to have you, Mr. Ballot, if you will, describe the mechanism and arrangement of this small scale machine which was designed for the continuous drawing off of the froth?

A. This special small scale apparatus, as referred to as I understand the question, consisted of one square box with glass sides. The agitator was suspended from the top by means of a shaft and had instead of a cone a simple cross made of two crossed blades of metal which formed the beater or agitator. The shaft was driven either by a small motor coupled direct to it or by pulleys. The spitzkast was outside with a small rubber tube connection from near the bottom of the agitation box to the spitzkast, feeding in part of the way down or over the little apron or launder as the case may be. I would here say that I am not sure whether at one time or another this particular apparatus did not consist of two spitz boxes worked side by

Deposition of John Ballot.

side with a tube or pipe connection from the one to the other, the agitated pulp being fed into the spitz at the end of the second box as before described.

Q. 71. In carrying out the process which the patent in suit purports to disclose, what degree of agitation did you give to the oiled and acidified pulp?

A. So far as my memory serves me, various agita- tors ~~tions~~ were revolved at different speeds according to their size and the size of the vessel in which they were used, but I think that in practice generally a speed varying from one thousand to sixteen hundred, and sometimes more, peripheral feet per minute is usually found to be an efficient degree of agitation.

Q. 72. How did the degree of agitation imparted to the pulp in the practice of the operations set forth in the patent in suit compare with that used in practicing the Cattermole process which is referred to in the patent in suit?

A. In the Cattermole process, if I remember rightly, there were two degrees of agitation. In the first series of mixers the agitation was fairly violent to disseminate the oil throughout the pulp and to coat the mineral particles. In the second portion of the process a very much slower rolling motion was given to enable the mineral particles to attach themselves to one another and to be rolled into small shot-like granules.

Q. 73. Which of the two kinds of agitation used in the Cattermole process was employed in practicing the operations set forth in the patent in suit?

A. The first, but in a more violent degree, because

the quantity of oil being so much smaller than that used in the Cattermole it required more agitation to disseminate it throughout the pulp for the purpose of coating the mineral or being attached to the mineral.

Q. 74. In carrying out the operations of the patent in suit is there any relation between the amount of oil used and the viscosity of the oil?

A. I do not think there is any relation as to the viscosity provided the oil is in a thin liquid condition so that it can be easily disseminated throughout the pulp. If an oil like oleic acid were to be solidified or thickened by cold it would naturally be necessary to warm it up to liquefy it.

Q. 75. Has it been your experience that different ores required different amounts of the same oil and that the same ore requires different amounts of different oils in the practice of the operations set forth in the patent in suit?

A. Yes, I think that is so.

Q. 76. I understand that a great deal of your experimentation with the operations of the patent in suit has been conducted upon ore or tailings from Broken Hill, Australia. Did you find that these ores and tailings did, or did not, contain calcite?

A. I believe they all contain calcite, some very little and others a good deal more.

Q. 77. Was the process which was tried at the Minerals Separation plant in Wales adopted by the San Francisco Del Oro mine for the treatment of its ore or tailings at the mine?

Deposition of John Ballot.

A. The San Francisco Del Oro took a license from us but up till now the process has not been installed at the mine because of the fact that its calcite and fluorite contents cause a very heavy consumption of acid which the company think at the present time would not yield them a commercial result if they have to import their acid, as they have to do at present.

Q. 78. During your investigation, that is, the investigations of Minerals Separation, Limited, into the Cattermole process, during the two years or more preceding the year 1905, I presume the Cattermole process was operated under varying conditions as to degree of agitation, amount of acid, oil, dilution of pulp and so forth for the purpose of ascertaining the value of that process. Am I correct in this?

A. That was so.

Q. 79. In some of the documents which have been referred to, Messrs. Sulman & Picard referred to a Mr. Pudsey. Will you state Mr. Pudsey's connection with the work of Minerals Separation?

A. Pudsey was member of Messrs. Sulman & Picard's staff while they were carrying out investigations in the Cattermole process for the owners of the Cattermole process before it was acquired by Minerals Separation, Limited.

Q. 80. Do you know Mr. Pudsey's first name and present address?

A. I regret to say I do not.

Q. 81. Is the plant of Minerals Separation in Wales still being operated?

Deposition of John Ballot.

A. The plant never belonged to Minerals Separation, it was a Minerals Separation plant put up at the request of the San Francisco Del Oro Company by Minerals Separation for the purpose of producing concentrates from a shipment of several hundred tons of ore sent to England which that company wished to use to test a special zinc smelting process. It was only used to produce those concentrates, which it did successfully, but what has become of it I do not know.

Q. 82. You are the John Ballot who is one of the grantees of the patent in suit, are you not?

A. I am.

Q. 83. During the investigation of the Cattermole process and the development of the process to which the patent in suit relates, did you personally perform any of the experimental work in the laboratory or other plant?

A. No, I never personally carried out any experimental work, that is, I never manipulated the experimentation myself, only directed or assisted in directing the experiments.

Q. 84. Will you state what your education or experience has been as a chemist or metallurgist?

A. I have had no school education in either chemistry or metallurgy except in the elementary stages. My practical experience has been gained over a period of some ten or eleven years while in South Africa at the Witwatersrand gold fields as a mine owner myself or as managing director of several gold-mining companies, where I closely followed practical opera-

tions connected with that industry; and since 1901 I became closely connected, and have ever since followed, the development of oil processes in London, and have been in close touch with chemists, metallurgists and engineers during investigations of such processes, and have been practically ever since, which connection has given me the experience that has enabled me to make Minerals Separation the success it is.

Q. 85. Did any other members of the staff of Minerals Separation, besides Mr. Higgins and Mr. T. J. Hoover, go to Australia under instructions from Minerals Separation, Ltd., in connection with the Cattermole or the flotation process?

A. Apart from Mr. Chapman we sent out Mr. A. H. Higgins and Mr. Rasmus J. Harvey. After that we sent out Mr. A. K. Burn, and Mr. E. H. Nutter was sent out in the early part of 1910.

Q. 86. Can you state the present whereabouts of Mr. Harvey or Mr. Burn?

A. Mr. Harvey is still employed at the Sulphide Corporation, Broken Hill. Mr. Burn, I understand, is at present engaged in the erection of a Minerals Separation plant at the Cuba Copper Co.'s mines in Cuba.

Q. 87. On page 8 of Messrs. Sulman & Picard's report of March 3rd, 1905, addressed to you, I find a reference to "a combination of the float and soap process, *i. e.*, by what is generally known as the Froment process." Did this reference to the Froment process convey a definite idea to you?

Deposition of John Ballot.

A. In connection with the Nagyag ores referred to by Messrs. Sulman & Picard it did convey a definite idea, because the Nagyag ores, if I remember rightly, contained a considerable percentage of calcite so that by adding a sufficiency of soap the slimes were agglomerated completely and were well agitated to insure their complete intermixture when a small amount of acid was well stirred in and the usual float could be obtained by the Froment process.

Q. 88. When did you first learn of the Froment process, Mr. Ballot?

A. I think it was some time in August, 1903, by publication of an abstract of the specification.

Q. 89. Referring to the operation described in your answer to question 87, what means were employed for stirring the acid into the intermixture there referred to?

A. It is difficult to answer that from memory of that particular experiment, but at that time I know the general practice was to first of all mix the oil and water, etc., thoroughly and then stir in the acid gently by means of a stirring rod.

Q. 90. When did you first learn of the use of oil or fatty matter as a means of producing the flotation of part of the constituents of an ore suspended in water?

A. The action of an oil was first known to me almost in my school-boy days in so far as it relates to the greased needle effect. The accidental flotation of small portions of granulated mineral I think first appeared during the Cattermole investigations. The

Deposition of John Ballot.

flotation of oiled mineral by means of gas chemically generated and liberated in a pulp first became known to me by the Cattermole Sulman & Picard process or discovery taken out by them before Froment's patent was published. I have not included the oil buoyancy process of Elmore, which I studied during 1901 and 1902, as being referred to in this question.

Q. 91. Did you ever see a froth produced upon a pulp containing more than 1 per cent. oil, that is, the amount of oil equal to more than 1 per cent. of the ore?

A. I have seen the gas bubble froth effect as produced by the Froment process, caused by liberating a gass in the pulp, but I have never seen a froth of the character produced by the patent in suit, with that quantity of oil.

Adjourned to Wednesday, the 14th of August, 1912, at 2 o'clock in the afternoon, at the same place.

Deposition of John Ballot.

Direct examination of John Ballot continued:

Q. 92. In questions 68 and 70 and the answers thereto as well as elsewhere in your testimony, reference has been made to a small scale apparatus from which the froth was to be taken continuously. Will you state whether apparatus similar in general char-

but on a much larger scale, was so far as my memory serves me, first introduced at Cowper street. This consisted of a number of agitating boxes in series, the pulp passing from one to another and after sufficient agitation, with of course the addition of the oil and acid and ore, the finished pulp was fed into a spitzkast. At Cowper street also we had a smaller scale plant consisting of a battery of some five or six gabbet mixers from which the pulp, after having received the necessary treatment, agitation, etc., was led into a spitzkast somewhat about half way down so that the discharge took place well under the surface of the liquid in the spitzkast.

Q. 93. Will you kindly state if subsequent to this apparatus constructed on Cowper street still others

Deposition of John Ballot.

flotation of oiled mineral by means of gas chemically

P. 1744, L. 4, insert " flotation process and the Sulman and Picard " before " process "

was published. I have not included the oil buoyancy process of Elmore, which I studied during 1901 and 1902, as being referred to in this question.

Q. 91. Did you ever see a froth produced upon a pulp containing more than 1 per cent. oil, that is, the amount of oil equal to more than 1 per cent. of the ore?

P. 1744, L. 14, insert " type or the Sulman and Picard's bubble type of " before " process "

quantity of oil.

Adjourned to Wednesday, the 14th of August, 1912, at 2 o'clock in the afternoon, at the same place.

Deposition of John Ballot.

LONDON, August 14th, 1912.

Met pursuant to adjournment. Present counsel as before.

Direct examination of John Ballot continued:

Q. 92. In questions 68 and 70 and the answers thereto as well as elsewhere in your testimony, reference has been made to a small scale apparatus from which the froth was to be taken continuously. Will you state whether apparatus similar in general character to the particular apparatus referred to had previously been constructed and tried by Minerals Separation, Ltd.?

A. The square box agitator as a continuous plant, but on a much larger scale, was so far as my memory serves me, first introduced at Cowper street. This consisted of a number of agitating boxes in series, the pulp passing from one to another and after sufficient agitation, with of course the addition of the oil and acid and ore, the finished pulp was fed into a spitzkast. At Cowper street also we had a smaller scale plant consisting of a battery of some five or six gabbet mixers from which the pulp, after having received the necessary treatment, agitation, etc., was led into a spitzkast somewhat about half way down so that the discharge took place well under the surface of the liquid in the spitzkast.

Q. 93. Will you kindly state if subsequent to this apparatus constructed on Cowper street still others

of the same general type, whether on a large or small scale, were constructed and tried by Minerals Separation, Ltd.?

A. At Charlotte street a large scale plant consisting of six or eight square agitation boxes, I am not quite certain as to the number, was put up, which likewise discharged the finished pulp on to a spitzkast, and the residues from the first spitzkast were dropped on to an apron feeding same into a second spitzkast and I believe later on one or two more spitzkasten were erected below the second one for the purpose of experiment and investigation to determine how far any sunken mineral could be recovered by flotation.

Q. 94. After the construction and trial of this plant on Charlotte street were any more apparatuses of this general type built and tried, prior to the construction of the one referred to in your reply to question 70?

A. I have no distinct recollection of small scale plants such as referred to in question 70, but I do recollect that the larger scale plant referred to in my previous answer was somewhat modified under the direction of Mr. T. J. Hoover simplifying the frothing arrangement very much by making the plant more compact, and resulted in the construction of the larger scale plant referred to in my answer to question 62. I would like to add that research or investigation was going on all the time with a view to discovering a handy apparatus for small laboratory test work that would closely approximate the operation of the larger

Deposition of John Ballot.

scale or commercial plant, but I do not remember details.

Q. 95. How did these various apparatuses which were constructed and tried prior to the apparatus described by you in answer to question 70, compare in the results secured by their operation with the results secured by the operation of the apparatus described in answer to question 70?

A. I do not think the apparatus described in my answer to question 70 was successful or comparative with that of the other continuous apparatus referred to in the question because I understood that its use was very soon abandoned.

Q. 96. In the operation of the apparatus constructed prior to that referred to in answer to question 70, to what extent was the valuable content of the ore recovered in the form of a froth as distinguished from what we have referred to as a film?

A. In answering the question I will take the last part first. I do not understand the reference as to film. The metal content or valuable content were certainly recovered as a froth.

Q. 97. By the term "film" I referred to particles of the metalliferous mineral, sulphides I believe in the ores which you experimented mostly with, which had been oiled and which floated upon the surface of the water, not in the form of a froth containing bubbles and of substantial thickness, say an inch or two, but floating after the manner that a greased needle floats upon the surface of water. My inquiry was directed

to ascertain whether in the operation of these machines constructed prior to that described by you in answer to question 70 more or less of the floating mineral did not take the form of a film, as so defined. With this explanation will you kindly answer the question.

A. In the frothing process film flotation such as you describe in the question under reply, if it took place at all, would be considered as a sure indication that there was something wrong in the preparation of the pulp, either by insufficient agitation, or additions of oil or acid, or in the proportions or ore and water. It is true that at the beginning of a test or towards the end of a test, indications of film may appear, but they only do so because of the altered condition whereby a smaller quantity of mineral froth is produced, brought on the surface of the spitz water and there possibly spread out by the force known as surface tension.

Q. 98. During the operation of all of these machines constructed prior to the machine referred to in your answer to question 70, did not this film of floating mineral appear at other times than at the beginning of the operation of the apparatus and at the shutting down of the operation?

A. It may have appeared when the conditions were faulty, and in fact it was always an indicator that something was wrong with the conditions of the test.

Q. 99. Did you ever find out what it was that was wrong so that you could operate these apparatuses for long periods, say for a day, without the appear-

Deposition of John Ballot.

ance of a considerable amount of mineral floating as a film instead of as a froth?

A. I do not think any trouble was ever experienced in correcting it if it appeared at all. In our test plant in London, however, it was not frequently possible, or perhaps possible at all, to run a continuous test lasting over a whole day, simply because ore was scarce and expensive to obtain, and such ore as we had, had to be made use of as carefully as possible.

Q. 100. You qualify your answer by prefacing it that you do not think. Do you state unqualifiedly that the production of this mineral floating in the form of a film as distinguished from a froth, was not a most frequent occurrence and one that engaged your attention and that of your associates and the staff of Minerals Separation in an endeavor to eliminate the film flotation and secure uniform froth flotation?

A. I do not remember any case where we failed in correcting it, if it occurred at all. The reduction of the area at the spitz box easily regulated that by keeping the froth closer together and preventing it being spread over an unduly large surface of water so that the question became a mechanical one of determining the most suitable spitz area and that was adjusted by having movable boards or baffles which were put in as circumstances required it.

Q. 101. Which machine of those you have referred to was fitted with these movable boards or baffles for the purpose of regulating the area of the spitz boxes?

A. I believe we used these movable boards, either as sheets of glass or as thin wooden strips, even so early as at Cowper street, when the multiple spitz was in use of the character shown in Figure 1 of the patent in suit.

Q. 102. Will you state the period of time that your laboratory was at Cowper street?

A. From June 24th, 1905, to 24th June, 1907, but the dates I give you here were those of the lease of the premises. Charlotte street was taken on the 19th January, 1907.

Q. 103. Please state the period of time during which you occupied the laboratory at Charlotte street and the other laboratories in which flotation investigation was conducted.

A. Aldermanbury avenue, tenancy commenced March 24, 1904, ended June 24, 1905. Cowper street, tenancy commenced June 24, 1905, ended June 24, 1907. Phipp street, an auxiliary laboratory for dry-table experiments, tenancy commenced September 29, 1905, ended September 29, 1907. Charlotte street, tenancy commenced January 19, 1907, ended December 25, 1910. King John's court, tenancy commenced June 24, 1910, and is still continuing.

Q. 104. Will you explain the manner in which these movable boards or baffles were manipulated?

A. They were placed longitudinally across the spitzkast from the side where the pulp entered to the overflow, either one at a time, leaving the one side of the spitz to form one wall of the partition, or when

using two boards they were placed inside the spitz in the same direction so as to narrow the channel along which the froth traveled to the overflow lip.

Q. 105. I will read to you a question that was put to you as a witness, and your answer thereto, in a suit in the King's Bench Division in the High Court of Justice, this suit having been brought by the Ore Concentration Company, Limited, against Webster and others, including yourself, and ask you whether in that suit you did in fact answer such a question in the words which I now read to you? The question and answer are as follows:

> "1062. Just tell his Lordship why your name is mentioned in some of these patents, the first one is, I think—if I am wrong correct me—an application of the 13th January, 1905, 1821 of 1905. The applicants are Sulman, Picard and Ballot. Then you come into some others. How was it your name comes into those patents?—First because I was chairman of the Minerals Separation, and when these inventions were made I was specially directed by the directors of Minerals Separation to have my name added to it as a matter of extra protection for the company.
>
> "1063. You yourself taking an interest in the development of these patents?—I took a very considerable interest in it, closely watching the better part and watching everything that was going on.

> "1064. You mean the experiments?—In the experiments, and naturally suggested anything and everything that I could think of."

A. Yes.

Q. 106. One of the issues of the suit from which I have quoted your testimony was the ownership of, or rights under, certain patents in which the Ore Concentration Company, Limited, claimed an interest, was it not?

A. I think I should have the opportunity to refresh my memory before I answer these questions.

Q. 107. The controversy in this suit from which I have quoted part of your testimony involved certain patents which the defendants, Webster, Godlonton and yourself either owned or had an interest in, did it not?

A. Neither Webster, Godlonton nor myself owned any patents.

Q. 108. Can you state in a general way what the suit from which I have quoted your testimony was about, and to what extent any patents were involved in that controversy?

A. The object of the suit was to enforce an old contract under which the defendants took an option from the Elmores for their Australian rights of their bulk flotation oil process in 1901 to October, 1902, and claiming under that contract that the patents then owned by Minerals Separation, Limited, were the property of the defendants and should be assigned to the complainant.

Deposition of John Ballot.

Q. 109. Among the patents so owned by Minerals Separation, Ltd., was there included the British patent containing the subject-matter of the United States patent 835,120 involved in the suit in which you are giving your deposition?

A. I believe so.

Q. 110. From your testimony above quoted I understand that in some cases your name has appeared as a grantee of British patents in cases where you were not the inventor of the subject-matter thereof, as I understand is permissible under the British law. Am I correct in this?

A. As a matter of fact I do not believe that my name has appeared in any cases in the invention of which I did not participate.

Q. 111. The reason which you give in your testimony quoted above why your name appears upon the patents therein referred to is that you were chairman of the Minerals Separation and were specially directed by the directors to have your name added as a matter of extra protection for the company. That would be sufficient reason in itself, would it not?

> BY MR. WILLIAMS: Objected to as not properly stating the subject-matter of the testimony referred to.

A. That was not the reason why my name appeared in the patent in suit or the corresponding British patent. What I stated to the court at that time was perfectly true, that the board of the company

thought it advisable for me to have my name added to patents, but our patent agents advised differently, as is evidenced also by a number of patents owned by our company on which my name did not appear.

Q. 112. So far as British patents were concerned it would have been perfectly proper for the application to have been made in your name and for the grant to have been made to you regardless of whether or not you were the inventor or one of the inventors?

By Mr. Williams: Objected to as incompetent, the witness not having qualified as an expert having knowledge of British patent law. The offer is made to stipulate as to what is the law and the witness is directed not to answer the question.

By Mr. Scott: Question withdrawn.

Q. 113. What part did you have in the invention of the process claimed in United States patent 835,479 and the corresponding British patent?

A. It is impossible to tell you what particular part I had in the invention as Messrs. Sulman, Picard and myself collaborated and consulted daily and between the three of us we undoubtedly evolved the process and the apparatus.

Q. 114. Do you remember with whom the idea of using gas pressure as set forth in the claims of this patent, originated?

A. No, I do not remember. It was the product of our joint conferences or consultations.

Deposition of John Ballot.

Q. 115. Do you remember that you had any part personally in originating the idea of using gas pressure?

A. It is impossible to differentiate the part I had in it from any part by Sulman and Picard.

Q. 116. I notice that the process of this patent is defined in the first claim as consisting of suspending the powdered minerals in a liquid, subjecting the mixture to a gas pressure and thereafter relieving the pressure. From your testimony regarding your familiarity with the metallurgic art I assume that at the date of the invention set forth in the patent 835,479, the idea of suspending powdered minerals in liquid was known to you to be very old, was it not?

A. Yes, if translating it into plain language, you mean finely pulverized or crushed ore whether crushed dry or wet; if crushed dry to mix it with water, thereby suspending it in the liquid.

Q. 117. And you cannot state who originated the remaining steps set forth in this claim, namely, submitting the mixture to a gas pressure and thereafter relieving the pressure?

A. I can only say that Sulman, Picard and Ballot did it jointly.

Q. 118. You cannot state any facts, then, upon which you base your conclusion that this idea of subjecting the mixture to gas pressure and thereafter relieving the pressure was done by yourself, Messrs. Sulman and Picard jointly?

A. I remember distinctly that we experimented with a soda siphon, put the charge in that, with sufficient quantities of oil and acid, then pumped in air, and then quite easily shook it, agitating it by shaking with the hand, and liberating it by discharging the contents into a separate beaker, when the flotation effect was noted. Later on we broke off the stem just below the neck of the bottle, put in the charge into a partially filled siphon, agitated it and simply let off the pressure by touching the lever. (Witness illustrates with a siphon of soda water.)

Q. 119. Do you remember who first performed this experiment with the soda siphon?

A. I do not remember at all.

Adjourned to Thursday, August 15th, at 3 o'clock P. M., at the same place.

LONDON, August 15th, 1912.

Met pursuant to adjournment. Present counsel as before.

Direct examination of Mr. Ballot continued:

Q. 120. When did you first see a demonstration of the process which the patent in suit purports to set forth?

A. If by demonstration you mean the phenomenon of the mineral contents rising to the surface in the form of a froth, I first saw that somewhere between the 3rd and 10th of March, 1905, while Mr. Higgins was carrying out the programme of work set him by

Deposition of John Ballot.

Sulman, Picard and myself, and especially while he was step by step reducing the percentage of oil used in the experiments.

Q. 121. And who was present upon this occasion?

A. On the first occasion I think Mr. Higgins and myself and possibly Mr. Leechman, but I am not sure of that.

Q. 122. How did you happen to be present?

A. Simply because I was closely interested not only in the special programme of work set Mr. Higgins by Sulman, Picard and myself, but in all research or experimental work being carried out, and I made it a daily practice of visiting the test works at Aldermanbury avenue, sometimes more than once a day, and I also as often as possible visited Sulman and Picard in their own laboratory where they were carrying out investigations, and I was naturally anxious to see the developments of the experiments or tests, I do not know the exact word, carried out by Mr. Higgins, especially so because during the earlier part of his experiments when he had reached the limits of about .5 or .6 per cent. considerably more mineral float appeared on the surface, which rather puzzled us.

Q. 123. Can you state approximately the date when you received the description and instructions, accompanied with drawings, from Mr. Froment?

A. These were received at my office about December, 1903.

Q. 124. It was at least as early as December 30th, 1903, was it not?

Deposition of John Ballot.

A. Yes, that is so.

Q. 125. Will you state, if you can remember, what kind of an apparatus Mr. Higgins was using in his work at the time he was reducing the amount of oil, as you have stated?

A. He used what we generally describe as a single gabbet, which consisted of a cylindrical vessel with a hemispherical bottom set in a brass mounting. The agitation was performed by means of a cone mounted on a shaft, suspended into the gabbet and driven either by a small motor, coupled direct to the shaft, or by a belt and pulley, and over the sides of the mixing vessel four movable baffles were adjusted well into the pulp contents of the charge. These baffles just described were at will removed or reintroduced in the course of the operation, as the operator desired.

Q. 126. Is Mr. Higgins to whom you have referred still employed by Minerals Separation, Ltd?

A. Yes, he is.

Direct examination closed.

Cross-examination by Mr. Williams.

X-Q. 127. You have spoken of a programme of work set for Mr. Higgins by Messrs. Sulman, Picard and yourself. In what manner, if you know, were instructions transmitted to Mr. Higgins to carry out this programme of work?

A. Program was prepared by us in writing and that was handed to Mr. Higgins by Mr. Sulman in my presence.

Deposition of John Ballot.

X-Q. 128. Has Mr. A. Howard Higgins ever to your knowledge claimed to be the inventor of the agitation-froth process of the patent in suit?

A. No, sir, he has not, and he has placed on record a confiirmation of this in an affidavit sworn to by him.

> BY MR. SCOTT: The preceding answer is objected to as secondary evidence in that the affidavit referred to is the best evidence of what Mr. Higgins set forth therein.

ticulars relative to the letters patent in suit and the installation and use of the process of ore concentration constituting the invention set forth in that patent, and in that and succeeding answers you confined yourself to what took place before Mr. Hyde went to Mexico. Have you anything further to add as to such instructions after Mr. Hyde had left London to go to Mexico?

A. While Mr. Hyde was absent in Mexico, the United States and Canada, he was continually informed of how to test certain ores and what particular oils to use in experimenting with the same. In short, he was kept fully informed of everything that we thought it necessary or expedient that he should know or be informed upon. On his return to London we placed at his disposal all Mr. Nutter's reports on the Australian plant and position, as well as a particular

Deposition of John Ballot.

A. Yes, that is so.

Q. 125. Will you state, if you can remember, what kind of an apparatus Mr. Higgins was using in his work at the time he was reducing the amount of oil, as you have stated?

A. He used what we generally describe as a single gabbet, which consisted of a cylindrical vessel with a hemispherical bottom set in a brass mounting. The agitation was performed by means of a cone mounted on a shaft, suspended into the gabbet and driven either by a small motor, coupled direct to the shaft, or by

P. 1758, L. 14, insert " so as to reach down on the inside of the mixing vessel " before " well "

scribed were at will removed or reintroduced in the course of the operation, as the operator desired.

Q. 126. Is Mr. Higgins to whom you have referred still employed by Minerals Separation, Ltd?

A. Yes, he is.

Direct examination closed.

Cross-examination by Mr. Williams.

X-Q. 127. You have spoken of a programme of work set for Mr. Higgins by Messrs. Sulman, Picard and yourself. In what manner, if you know, were instructions transmitted to Mr. Higgins to carry out this programme of work?

A. Program was prepared by us in writing and that was handed to Mr. Higgins by Mr. Sulman in my presence.

Deposition of John Ballot.

X-Q. 128. Has Mr. A. Howard Higgins ever to your knowledge claimed to be the inventor of the agitation-froth process of the patent in suit?

A. No, sir, he has not, and he has placed on record a confiirmation of this in an affidavit sworn to by him.

> By Mr. Scott: The preceding answer is objected to as secondary evidence in that the affidavit referred to is the best evidence of what Mr. Higgins set forth therein.

X-Q. 129. In Q. 6 you were asked to state any particular or specific instructions which were given to the defendant as to the technical details and particulars relative to the letters patent in suit and the installation and use of the process of ore concentration constituting the invention set forth in that patent, and in that and succeeding answers you confined yourself to what took place before Mr. Hyde went to Mexico. Have you anything further to add as to such instructions after Mr. Hyde had left London to go to Mexico?

A. While Mr. Hyde was absent in Mexico, the United States and Canada, he was continually informed of how to test certain ores and what particular oils to use in experimenting with the same. In short, he was kept fully informed of everything that we thought it necessary or expedient that he should know or be informed upon. On his return to London we placed at his disposal all Mr. Nutter's reports on the Australian plant and position, as well as a particular

Deposition of John Ballot.

document dealing with the future development or technical development of Minerals Separation process dated 3rd December, 1910, which document I now produce. He was also shown our new works at King John's court with all the plant as then at work including the froth-trap apparatus which was specially designed to produce a high recovery but a low grade concentrate, the object and intention being to retreat these low grade concentrates by flotation in the ordinary way, and in general I discussed with Mr. Hyde even such confidential matters as the appointments of agents in the United States and requested him to give me his opinion, which he did in writing. I also requested Mr. Hyde to bring up a memorandum as the result of his investigations and experience on the North American position with a view to carrying on an active campaign in the countries included, under his own supervision as one of several technical engineers we had in view for the purpose. I now produce this document dated the 8th January, 1911, and signed by Mr. James M. Hyde.

> At the request of counsel for the complainants the Commissioner marks for identification the two documents produced by the witness as "Nutter Report December 3, 1910," and "Hyde Report January 8, 1911."

X-Q. 130. You have spoken of a Mexican syndicate. How long did this syndicate continue in the form in which you have described it?

Deposition of John Ballot.

A. It continued during the greater part of the year Mr. Hyde was with us, when it was acquired by Minerals Separation American Syndicate, Limited, one of the complainants, soon after October, 1910. The formal agreement was signed on January 12, 1911.

X-Q. 131. When Mr. Hyde was sent to Mexico with testing machines of the slide type, as you have testified, were any instructions given to him as to these machines, with a special regard to publicity of their exhibition and use?

A. He was requested by me to keep the machine as confidential as possible and even if need be to get a special room in which to carry on his test privately. The machine itself had not been patented by us and we naturally did not wish too much information to be given to the public on that account. I would add that when he left our service he was requested to immediately return the machine to our custody or to that of our agents. This I believe was done in the course of time.

X-Q. 132. In connection with the description and drawings received from Mr. Froment, did you receive any apparatus from him?

A. Yes.

X-Q. 133. Have you made a search for this apparatus and can you produce it?

A. I have had a search made but it could not be found, and I fear it has been scrapped.

X-Q. 134. Please describe this apparatus received from Mr. Froment.

Deposition of John Ballot.

A. The apparatus consisted of a round or cylindrical mixing vessel, mounted on three or four legs. It was built of sheet iron, and as a mixer it was fitted with an arrangement consisting of two beaters made of stout wire, somewhat like grid-irons, but so arranged that while revolving in opposite directions, the wires freely passed between one another. I could perhaps better illustrate it by referring to a common form of egg beater. These agitators were driven by a suitable gear, and the mixing vessel was fitted with a discharge tap. The next part of the apparatus consisted of a circular tank. Into this was fitted a coil of lead pipe, with one end projecting above the rim of the vessel. The coil itself was placed near the bottom, and the pipe was perforated with small holes. In addition to this, there was fitted to this tank an apparatus resembling a rake, which was fixed to a vertical spindle. This spindle was mounted from bearings over the tank, and, if I remember rightly, had a handle fixed to the upper end, with which to revolve it in operating the plant. The third part of the apparatus consisted of a rectangular wooden tank or box, into which was fitted, just about the water level, a sheet of perforated aluminum, which was connected with a mechanical device overhanging the tank, in such a way that it could be freely rocked or shaken by means of a series of impacts imparted to a spring. The gear giving the impacts was, I think, arranged outside, to be driven by hand. This, I believe, generally described the apparatus we received from Mr. Froment.

X-Q. 135. What was the final outcome, and what in general the proceedings in the suit referred to in Q. 105, and a few succeeding questions?

A. There were two trials and one appeal. At the second trial the plaintiffs, through their counsel, withdrew their allegation and publicly apologized, and the suit was discontinued.

Cross-examination closed.

Re-Direct Examination by Mr. Scott.

R-D. Q. 136. Referring to the document which has been identified as Nutter Report, December 4, 1910, will you state what Mr. Nutter said about how greatly the recoveries were affected by variations in the rate of addition of oil and acid, this matter being referred to by him on pages 27 and 28, as having been the subject of a previous report, and will you produce that report?

A. I now produce Mr. Nutter's report, dated July 28, 1910, entitled "A Report on the costs of construction and operation of the Minerals Separation Plant at Broken Hill, N. S. W.," which contains, under the heading of "Recoveries," the subject-matter inquired of in the question.

At the request of counsel for complainants, Commissioner marks for identification the report just produced by the witness as "Nutter Report, July 28, 1910."

Deposition of John Ballot.

R-D. Q. 137. What is the source of your information or belief that the document identified as "Nutter Report, December 3, 1910," was placed at the disposal of or seen by Mr. Hyde, the defendant.

A. I instructed Mr. Nutter early in 1911 to supply Mr. Hyde with a copy. Mr. Nutter informed me that he had only one copy left of his own, but he would pass that on to Mr. Hyde. Mr. Hyde himself soon after informed me that he had received it from Nutter and had carefully studied it.

R-D. Q. 138. After the acquisition of the Mexican Syndicate by Minerals Separation, American Syndicate, Ltd., was the contract or arrangement with Mr. Hyde, the defendant, reformed or modified in any way?

A. No, sir, and Mr. Hyde was paid by check by the Minerals Separation, American Syndicate, and accounted for monies received and rendered his final account to that corporation. I have the accounts and checks here.

Re-direct examination closed.

Re-Cross Examination by Mr. Williams.

R-X. Q. 139. During your re-direct examination you examined a file marked "Reports by E. H. Nutter." After having refreshed your memory, please state whether or not any one of these reports to Mr. Nutter was not shown to Mr. Hyde?

A. The report headed, "A Report on Administration Staff and Increase of Business in Australia" was

Deposition of John Ballot.

not shown. A memorandum from Mr. Nutter, headed "Memorandum," and signed "Edward H. Nutter," on the American business, was not shown to Mr. Hyde. A memorandum by Mr. Nutter in the treatment of the disseminated ores of Utah, Arizona and Nevada was not shown to Mr. Hyde.

R-X Q. 140. Can you state any reason why the three documents last referred to were not shown to Mr. Hyde?

A. The ~~last~~ report first referred to was not shown because it dealt with the Australian business and staff, which would not in the course of business have formed any part of Mr. Hyde's duties if he had continued his engagement. The second report referred to was a report made to me by Mr. Nutter as setting forth his views of handling the American business, and was a technical report for my private guidance, and for the guidance of the Board, in the same way as we had Mr. Hyde's report on the same subject of January 8, 1911. The third report referred to was probably of later date, after Mr. Hyde had left us.

R-X Q. 141. Now as to the report of Mr. Nutter, dated July 28, 1910, which you have produced, please state whether or not this report was shown to Mr. Hyde?

A. It was.

R-X Q. 142. Did you have any discussions with Mr. Hyde while he was in your employ as to the metallurgical situation in Butte, Montana; if so, please state their substance?

Deposition of John Ballot.

A. I had, early in January, 1911. You will notice that Mr. Hyde in his report of January 8, 1911, referred to Butte, Montana, in two places. The reason why I had a discussion with him about that was that during the latter part of 1910 Mr. Kuehn called on Mr. T. J. Hoover in his room at Minerals Separation offices. Mr. Hoover came to my room and asked me to come into his office, where he introduced Mr. Kuehn to me, and then mentioned that Mr. Kuehn had reported to him that there was a big mine at Butte, Montana, having a large body of zinc ore. We then both discussed it with Mr. Kuehn, and if I remember rightly, Mr. Kuehn told us that this had been a copper mine, but it had turned into a zinc mine lower down; at any rate, we thanked him for the information, and asked him to give us further particulars if he could do so, so that the existence of Butte and Superior was well known to Mr. T. J. Hoover and myself at the time. Hence I discussed it with Mr. Hyde, believing that he would be the engineer shortly to be entrusted with the development of our business in North America. I would refer also to a letter written to Mr. Hyde about the 23rd November, 1910, while he was still in America.

R-X Q. 143. Is the letter last referred to by you the letter referred to in X-Q. 72 of the deposition of the defendant, Mr. Hyde?

A. It is.

Re-cross examination closed.

Adjourned to Saturday, the 17th of August, 1912, at 10:30 in the morning, at the same place.

Deposition of John Ballot.

Re-Direct Examination by Mr. Scott.

By Mr. Scott: Now comes the defendant and objects to the answer of the witness to cross-question 129, and to cross-question 139, and the answer thereto, and to all of the testimony of this witness regarding alleged disclosures made to defendant, this objection being based upon the ground that all of such testimony is incompetent, irrelevant and immaterial, having no tendency to prove or disprove any matter at issue in this suit; upon the further ground that the testimony given in response to cross-questions 129 and 139 is irrelevant, immaterial and incompetent, and is further vague and trivial in that it does not appear from the witness' answer what is alleged to have been shown to the defendant, by reason of which vagueness in the witness' statement the defendant is denied the possibility of ascertaining the truth or falsity, as the case may be, of the witness' statement regarding alleged documents which have not been submitted to his inspection, and which the complainants refuse to so submit to the defendant for his inspection.

Notice is now given to the complainants that at the final hearing of this suit, or at some earlier date, of which due and timely notice will be given, a motion will be presented to the court that all of the testimony above referred to be expunged and stricken from the record.

Defendant further demands that complainants

deliver over into the custody of the Commissioner, by whom this proceeding is being conducted, all of the documents or papers of whatsoever character, the witness had in his possession and referred to during the giving of his testimony, in order that such documents and papers may be held by the Commissioner, subject to such rule as the court may enter upon the motion, of which notice is given above.

By Mr. Williams: The objection above stated, inclusive as it is of "all of the testimony of this witness regarding alleged disclosures made to defendant," is broad enough to include the answer of the witness to Q. 6, wherein he was asked by defendant's counsel to state any particular or specific instructions given to the defendant Mr. Hyde as to the subject-matter inquired of, and the demand is therefore that all of the confidential files of the complainants which were submitted to the inspection of the defendant, when he was employed in a confidential relation to the complainants, shall be now again opened to his inspection, when his position has materially and substantially altered. Cross-question 129 merely called for a further elaboration as to the subject-matter inquired of by defendant's counsel in Q. 6. In R-D. Q. 136 the witness was asked to produce a report specifically referred to in the Nutter Report of December 4, 1910, and the answer to this question of necessity required a search for this

report, and this report "Nutter Report, July 28, 1910," was produced. The situation appears to be that the defendant has inquired of his own witness as to certain facts, and has been replied to more fully than he expected, but the suggestion that these proceedings warrant a reopening to the defendant of all of the confidential documents of the complainants is obviously one which should not meet with the approval of this court, and obviously also there is no occasion for placing all of these confidential documents in the custody of the Commissioner. The witness is now before the Commissioner and ready to answer any inquiries relevant or material to the issues of this suit, and the documents produced and identified will be offered in evidence during the taking of complainant's rebuttal testimony.

By Mr. Scott: While mindful of the fact that this is not the occasion for argument, defendant insists upon his objection and demands that all papers referred to by the witness as having been shown to the defendant be either produced for defendant's inspection now, in order that defendant may govern his further action in this suit accordingly, or that the papers be delivered into the custody of the Commissioner pending the court's ruling upon the motion, of which notice is above given.

By Mr. Williams: No further documents than have already been produced will be produced, under existing conditions.

Deposition of John Ballot.

R-D. Q. 144. Will you state the date upon which Minerals Separation, Ltd., purchased the British patent to Froment, No. 12,778, of 1902?

A. In October or November, 1903. By referring to the agreement, I find it to be the 17th November, 1903.

> The Commissioner notes that the witness produces a document, and the same is marked for identification, "Assignment Froment to Ballot, 17th November, 1903."

R-D. Q. 145. I presume the assignment of this patent from Mr. Froment to yourself was made to you for the benefit of Minerals Separation, Limited, was it not?

A. Minerals Separation was not registered at that time, but the assignment was made to me, acting for and on behalf of the group of individuals who had acquired the Cattermole patents, and also some Sulman & Picard patents, which were taken over by Minerals Separation, Ltd., as soon as that company was formed. In fact, the Froment patents were acquired with the object of passing to Minerals Separation the moment that company could be formally registered.

R-D. Q. 146. And it was so assigned?

A. Yes, it was so assigned.

R-D. Q. 147. Were any tests made of the Froment process before the Froment patents were purchased by you on behalf of the parties you refer to?

Deposition of John Ballot.

A. Tests were naturally made by Sulman & Picard which led them to discover their own independent invention during July, 1903, and before the existence even of the Froment patents was known, and as soon as publication of Froment's patents took place, tests were carried out in small scale apparatus, according to that specification, that is, according to the directions given by the patentee.

R-D. Q. 148. Did you find it necessary to have Mr. Froment come to England, or to send someone to Italy, to negotiate the purchase of his patents?

A. I personally negotiated the purchase of Mr. Froment's patents with him in Italy, at ~~Milan~~ Turin, as set forth in the assignment of his patents, and while there I naturally asked Mr. Froment to give me all possible information, and also I asked him to send us plans and drawings, together with clear and definite instructions, as well as to have a model plant built and shipped to England for the purpose of carrying out his process as he recommended it should be done. This he promised to do, with the result that towards the end of the year the plans and instructions were received, and sometime early in 1904 the plant itself was received in London.

R-D. Q. 149. Did you have any negotiations with Mr. Froment prior to going to ~~Milan~~ Turin yourself for that purpose?

A. I think it was in the early part of August, 1903, we sent Mr. Freymuth to Italy to find out Mr. Froment's whereabouts and to open negotiations with him,

but Mr. Freymuth, although he found Froment, failed in bringing about any negotiations, so we instructed our patent agents in London to open negotiations through Mr. Froment's patent agent, Mr. Zanardo, of Rome, and that gentleman secured an option which led to me going to ~~Milan~~ Turin later on to meet Mr. Froment and Mr. Zanardo at ~~Milan~~ Turin by appointment.

Re-direct examination closed.

Deposition closed.

JOHN BALLOT.

Adjourned to Thursday, August 22nd, 1912, at 10:30 in the morning, at the same place.

London, August 16th, 1912.

Met pursuant to adjournment. Present, counsel as before.

HERBERT CLARK HOOVER, a witness produced on behalf of defendant, having been duly cautioned and sworn, testifies as follows:

Direct Examination by Mr. Scott.

Q. 1. What is your name, age, residence and occupation?

A. My name is Herbert Clark Hoover; my age is 37; my occupation is a mining engineer, and my residence is the Red House, Horton street, London, W.

Q. 2. Are you acquainted with Mr. Hyde, the defendant in this suit, and if so, for how long have you been acquainted with him?

Deposition of Herbert C. Hoover.

A. I have known Mr. Hyde about sixteen or seventeen years.

Q. 3. Did you ever engage Mr. Hyde as an engineer?

A. I engaged Mr. Hyde as an engineer for certain companies with whom I am associated in February, 1911. He was engaged in a general capacity of a mining engineer, and I think that he was in work in London about a month, and I asked him to accompany me to New York, as I had some mining business in Alaska and elsewhere that I wished his assistance with.

When I arrived in New York, Mr. A. Chester Beatty, with whom I have been associated, told me that he had looked into some business in Butte, Montana, in connection with a mine called the Butte and Superior, and at his instance I had some discussion with Mr. Stone, of Hayden, Stone & Co., as to the refinance of this company. As a result I detached Mr. Hyde from the other work which I had in view and asked him to go to Butte in conjunction with Mr. Kuehn in the examination of the Butte and Superior mine. My instructions to Mr. Hyde were that he was to take part in the examination of the mine, and particularly to look into the metallurgy of their ore. As the ore was a zinc ore, I told him to try all the various flotation methods and to report to me what the results were from this or any other metallurgical method that might suggest itself. While in London previous to going to New York, I had placed before Mr. Hyde the whole of the information and experience which I had in con-

nection with flotation methods other than those of the Minerals Separation Company, that is, the methods of De Bavay Potter, the Delprat and Elmore. Also I had placed before him the whole of the inquiry which I had had made into the Everson method, and in giving him his instructions with regard to the Butte and Superior I told him to try any or all of these methods, or anything else that suggested itself. Subsequently Mr. Hyde reported to me his opinion on this ore from a flotation point of view, but at that time it appeared to me that I had been left out of the financial end of the business, and as I recollect it, I told him that I was no longer interested, and he could do as he liked in connection with this business. So far as I was concerned, I closed my connection with the matter.

Q. 4. Have you had any experienec in putting into practice, or having put into practice, the Minerals Separation or Potter or Elmore process, to which you have referred?

A. Yes, I have been for many years the managing director of the Zinc Corporation, which is a company who have used these processes or methods on a large scale, and I have also been largely interested in the Amalgamated Zinc Company, who use flotation methods, and at one time I was interested in both the Potter Company and the Minerals Separation Company.

Q. 5. Was any effort made to have the process being exploited by Minerals Separation, Ltd., introduced into use by the Zinc Corporation, and if so, will you state what took place?

Deposition of Herbert C. Hoover.

A. In 1905 I first went to Broken Hill and took up the question of organizing the treatment of the zinciferous dumps and tailings from the Broken Hill mines, and did on account of myself and associates purchase large quantities of these materials, which were ultimately transferred to a company called the Zinc Corporation. At that time there were three flotation methods being exploited in Broken Hill, and I visited all of the plants. The Minerals Separation Company were operating the Cattermole process on the Central mine, the Block 14 Company were running a small plant on the Potter line, and the Broken Hill Proprietary were operating the salt cake or Delprat method. I engaged a metallurgical staff, and we delegated them to the inquiry, as to which of these methods we should adopt, and they adopted the Potter method. I might add also that the De Bavay method was also used at this time on the Broken Hill north mine. The Zinc Corporation installed the Potter method in their plant, and it subsequently proved a commercial failure. I went to London to Broken Hill again upon this event in the winter of 1907, and upon my instructions the mill was altered on to the methods in use by the Minerals Separation Company. These alterations were designed by the engineers of the Minerals Separation Company, and the plant was installed under their direction. They furnished us with a number of employees of experience to operate the plant, and in a general way had the supervision of its operation. This plant also proved a failure. After exhaustive trials of

the method we took up the Elmore method and found it successful, we subsequently built a much enlarged and very extensive mill on this line and operated it until some time in 1910. During a considerable portion of this period my brother, Mr. Theodore J. Hoover, had been acting as the general manager of the Minerals Separation Company, and he insistently presented to me the fact that he had made such alterations in the Minerals Separation method that the results were superior to those which we were obtaining by the Elmore method, and upon his insistence I had the matter reinvestigated. We carried out extensive trials with the modified plant of the Minerals Separation Company, and ultimately threw out the Elmore and re-adopted the Minerals Separation.

Q. 6. Is the Elmore process to which you have referred that which is sometimes called the Elmore vacuum process?

A. Yes.

Q. 7. Will you describe roughly the form in which the concentrate was recovered in these various processes, the Potter, Delprat, Elmore and Minerals Separation?

A. All of the processes, so far as I understand them, take off a scum or a froth over some form of spitzkasten.

Direct examination closed.

Deposition of Herbert C. Hoover.

Cross-Examination by Mr. Williams.

X-Q. 8. What process is now in use by the Zinc Corporation?

A. The method exploited by the Minerals Separation Company.

X-Q. 9. And, as I understand it, the Zinc Corporation have taken a license under the Minerals Separation patent, and pay a royalty to Minerals Separation, Ltd., based upon the tonnage of concentrates produced; that is true, is it not?

A. That is true. We took out such a license, but I do not want this construed as an opinion on the validity of their patents. The motives which guided the Zinc Corporation Board in taking out such a license were, first, the desire to reward the improvements in metallurgical practice, and, secondly, to have some responsible party who would guarantee the corporation immunity from litigation by the several other claimants to patent rights in these processes.

X-Q. 10. And it is true, is it not, that when you first installed the Minerals Separation process your company, the Zinc Corporation, took out a license under these patents of Minerals Separation, Ltd.?

A. They did.

X-Q. 11. It is also true, is it not, that the Zinc Corporation paid to Minerals Separation, Ltd., the sum of one thousand five hundred pounds in settlement of royalties due for the work done by Zinc Corporation under the first installation of Minerals Separation plant?

Deposition of Herbert C. Hoover.

A. Some sum of money was paid, I do not recollect the exact amount.

X-Q. 12. Could you give me a rough idea of the total annual payment of royalty made by the Zinc Corporation to Minerals Separation, Ltd., under the existing license agreement?

A. Our production amounts to roughly 90,000 tons of concentrates per annum, and we pay two shillings and sixpense per ton royalty.

X-Q. 13. What in full were the reasons which induced the Zinc Corporation to throw out the Elmore vacuum process and readopt the Minerals Separation process?

A. In the main we changed methods because it was possible to treat a larger proportion of slimes in the Minerals Separation method than in the Elmore. While we could secure much the same extraction by both methods, the gangue slimes came over to a greater extent with the concentrates in the Elmore method, and consequently the concentrate secured by the Elmore was of lower grade.

X-Q. 14. It was also true, was it not, that with the Elmore vacuum process you had been treating a high grade of ore, and that this high grade ore was very nearly exhausted?

A. The coarse material was at the same time the high grade material, and we had with the Elmore method exhausted a large proportion of our coarse material.

X-Q. 15. On the other hand, as I understand it, the

Deposition of Herbert C. Hoover.

Minerals Separation process has treated in a very satisfactory manner the lower grade and fine material, which was not profitably treatable by the Elmore vacuum process; this is true, is it not?

A. The first portion of the statement is true. The Minerals Separation process has treated the finer material more satisfactorily, but I would not add that this material was unprofitable by the Elmore method.

X-Q. 16. Perhaps we had better say not so profitable; would this be correct?

A. Yes.

X-Q. 17. In the Minerals Separation process as now carried on by the Zinc Corporation, what reagents are used?

A. Sulphuric acid and oil.

X-Q. 18. And, as I understand it, the mineral pulp is vigorously agitated with sulphuric acid and oil, and flows into a spitzkasten, upon the surface of which appears a mineral-bearing froth, which is separated as the concentrate?

A. It does.

X-Q. 19. At the time when Zinc Corporation first adopted a Minerals Separation process the process adopted was also one which would be describable by the language of my last question; this is true, is it not?

A. That is true in general lines.

X-Q. 20. At the time that Zinc Corporation discontinued the use of the first Minerals Separation plant, the Minerals Separation processes were in successful use, were they not, at Broken Hill, Australia?

Deposition of Herbert C. Hoover.

A. The process was not a commercial success in our plant, and I was advised that it was not a commercial success in other plants. I, however, cannot speak of this of my own knowledge.

X-Q. 21. Could you, without betraying any confidence, tell me who gave you such advice?

A. Our manager, Mr. Mitchell.

X-Q. 22. You saw this Minerals Separation plant in operation at the Zinc Corporation works, did you not?

A. I did.

X-Q. 23. What was the normal capacity of this plant?

A. If you refer to the first installation, as I recollect it, the capacity was designed for four hundred tons per day.

X-Q. 24. What was the financial condition of Zinc Corporation at the time that it made the change from the first Minerals Separation processes to the Elmore vacuum process?

A. The company had been practically bankrupted by the trial of the Minerals Separation process.

X-Q. 25. How long was the Minerals Separation process tried at that time?

A. My impression is that we were engaged in operating the process some four or five months.

X-Q. 26. And before that how long were you engaged in trying the Potter process?

A. We had it in operation about three months, I should think, in the completed mill.

X-Q. 27. And it was an incident, was it not, accom-

Deposition of Herbert C. Hoover.

panying the change from the first Minerals Separation plant to the Elmore vacuum process that Zinc Corporation floated a considerable quantity of preference shares of stock?

A. Yes, we were compelled to raise more capital to reorganize the business again.

X-Q. 28. You have spoken of certain improvements made by your brother, Mr. Theodore J. Hoover, in the Minerals Separation procedure? What, if you know, were these improvements?

A. They were largely in the direction of the mechanical devices in which the process was carried on. I do not pretend to have any great technical knowledge in the matter of these processes. My interest has always been on the commercial side.

X-Q. 29. You have said that the first Minerals Separation plant was installed under the direction of the engineers of Minerals Separation. Who were these engineers, if you know?

A. Mr. Chapman was the principal gentleman with whom I came in contact.

X-Q. 30. What in round numbers was the cost of the Elmore vacuum plant which was superseded by the Minerals Separation plant now in use?

A. This will require some explanation. We built a *de Novo* mill, with a new power plant, a new crushing plant, with railways, and so forth, together with a reconcentration plant, the whole cost running into probably £140,000. This mill had a capacity of about 1,000 tons per diem. When we introduced the Minerals Sep-

aration method the last time we spent something like £30,000 on the alterations. I do not exactly remember the figures, the above are approximations.

X-Q. 31. I have here what has been handed to me as the original table of the results and material treated by Zinc Corporation on the first installation of Minerals Separation plant during the period from May 2 to June 8, 1907, which shows a tonnage treated of 8,675, and concentrates produced as 1,891 tons, and which appears to show profitable operations.

A. I cannot identify the table. I do not assume that this was the total tonnage treated, or we should not have paid £1,500 in royalties on any such tonnage of concentrate. During the time that the mill operated the results were very erratic, and I do not know that on continuous occasions we came any way near the promised tonnage. I certainly do know that the plant was not operated at a profit.

X-Q. 32. Is it not a fact that the ore crushing facilities used in connection with this plant were inadequate?

A. According to the Minerals Separation Company's engineers, when they designed the plant, they were adequate. I recollect that subsequently the head tonnage was greatly reduced below the anticipated capacity in order to determine if this was the difficulty, and our engineers advised us that it was not.

X-Q. 33. It is true also, is it not, that on one occasion, when Mr. Chapman was present the plant was run under your direction up to 500 tons per day ca-

pacity, with the result that the mineral was not properly treated?

A. It is true that the plant was run at its anticipated capacity and proved wholly a failure at such a tonnage. The tonnage was subsequently greatly reduced without better results, from a commercial point of view.

X-Q. 34. What is the metallurgical situation in Broken Hill, Australia, which has brought about the great quantity of tailings now being treated for the extraction of valuable mineral therefrom?

A. Well, over a period of many years the Broken Hill mines were unable to profitably extract the zinc and there accumulated some ten to twelve million tons of mill residues, containing the major portion of the original zinc content. The invention of, or the application of the Potter, Delprat, Elmore, Cattermole and other methods, together with the mechanical variations and improvements which all of these flotation ideas have received, has enabled the accumulated zinc to be turned to profitable account. I may add that the great commercial prosperity of this district has been largely contributed to by the mechanical development of the long known flotation principle.

X-Q. 35. You understand, do you not, that the testimony which you are here giving for the defendant in this suit is being given voluntarily?

A. Yes, I came to give testimony entirely with the view to clear the charge which has been levelled at Mr. Hyde that he entered upon connection with the Butte and Superior Company as a result of information which

Deposition of Herbert C. Hoover.

he had obtained while in the employ of the Minerals Separation Company, which charge is not only untrue, but wicked.

X-Q. 36. Are you testifying here with the knowledge and consent of the Board of Directors of Zinc Corporation?

> By Mr. Scott: This question is objected to as incompetent, immaterial, and irrelevant, and having no bearing upon any issue of this case.

A. I am myself the managing director of the Zinc Corporation, I am violating no confidence in connection with that company's business. All the matters which I have stated are public property, and I am myself in any event entirely a free agent.

X-Q. 37. You have not answered my question, which was whether or not you are testifying here with the knowledge and consent of the Board of Directors of Zinc Corporation. Please answer this directly.

> By Mr. Scott: The objection last made is repeated.

A. The matter has never been before the Board of the Zinc Corporation, their approval has never been asked for.

X-Q. 38. When was your attention first called to the affairs of the Butte and Superior Copper Company of Butte, Montana?

A. So far as my recollection goes, I never heard of the Butte and Superior Company in my life until I

visited New York, in March, 1911, but as I stated before Mr. Beatty, with whom I am intimately associated in business, apparently had had some connection with this company some time previously.

X-Q. 39. I take it that when the matter of the Butte and Superior Copper Company was called to your attention it appealed to you as providing an opportunity for an investment in the re-financing proposition; this is true, is it not?

A. It did.

X-Q. 40. I take it also that the affairs of this company were then in such condition that financial aid had been called for?

A. I understood this company was desirous of raising further capital, and a proposal to take such an investment was put before me.

X-Q. 41. Did you in any way, directly or indirectly, participate in the financial scheme which finally resulted in this matter?

A. I did not, because after leaving New York the parties interested seemed to have forgotten the arrangement they entered into with me.

X-Q. 42. You have stated that Mr. Hyde reported to you his opinion of the Butte and Superior ore. What was that opinion?

A. I do not recollect the precise terms, but in substance it was to the effect that this company's profits could be greatly improved by the application of flotation methods to their ore treatment.

X-Q. 43. Have you assisted the defendant in the de-

fence of this suit otherwise than by appearing here as a witness?

A. I have not. I do not know enough about the technical matters involved, nor do I have any desire to take sides in the main issues of this litigation.

X-Q. 44. Had you not placed at his disposal certain documents that might be of assistance to him?

> By Mr. Scott: Question objected to as irrelevant, incompetent and immaterial.

A. I have no recollection of having given him any documents since this action began.

X-Q. 45. You supplied him with a typewritten copy of the record in the British suit of the British Ore Concentration Company and Elmore against Minerals Separation, Ltd., did you not?

> By Mr. Scott: Objection repeated.

A. I did not myself supply such a document; on Mr. Hyde's request, I placed him in communication with a firm of solicitors in London, who obtained for him the information that he wished.

X-Q. 46. Have you any interest, directly or indirectly, in the alleged invention disclosed in the patent to the defendant, No. 1,022,085?

A. I have not. Mr. Hyde offered to present me with an interest in his invention, and I told him that I would not accept an interest in any process, even as a gift.

X-Q. 47. Is it, or is it not, a fact that the opera-

tions of the Zinc Corporation in Australia involve the re-treatment of concentrates?

A. We do re-treat a portion of our concentrates to extract the lead. There are no patents on it, and any one can use it that likes.

X-Q. 48. And about how long has this retreatment practice been carried out by Zinc Corporation?

By Mr. Scott: The question is objected to as incompetent, irrelevant and immaterial, as having no tendency to prove or disprove any issue in this case.

A. We have been using re-treatment methods ever since we first built our first Potter mill.

X-Q. 49. And what have you done with the middlings from re-treatment?

By Mr. Scott: Preceding objection repeated.

A. So far as I know, the middlings are returned to the mill circuit and treated over again.

X-Q. 50. This you would consider as ordinary metallurgical practice, would you not?

By Mr. Scott: Objection repeated.

A. I presume that it has been found advantageous by our metallurgists. The matter, however, has been called into a good deal of question, as to its advantages or disadvantages.

X-Q. 51. The question is, of course, whether or not it pays to treat the middlings over again?

By Mr. Scott: Same objection.

Deposition of Herbert C. Hoover.

A. It is. So far as I know, the question is not entirely settled as to whether it is advantageous or not.

X-Q. 52. I have what purports to be Directors' Report and Statement of Accounts for the period ending 31st December, 1911, of the Zinc Corporation, Limited, containing what is entitled "Directors' Report," and which appears to have been signed Mr. F. A. Govett and yourself, as managing directors, and referring to an appended report of Mr. Theodore J. Hoover, and I find in this appended report the following statement, referring to work done with the vacuum machines stated to have been set aside:

> "And that while the material treated by the former method was very amenable to that method, it was a selection of material of the simplest metallurgical character amongst the Company's holdings, and that the remaining material was of such a character that it could not have been treated profitably by the former process."

Is the statement which I have quoted true or not?

A. The statement is no doubt true, but possibly a little overdrawn, as the sense intended was probably that the balance of the material could not be treated at nearly so great a profit.

X-Q. 53. One of the employments which the defendant entered into after leaving Minerals Separation was that of engineer for the Oroya Exploration Company; this is true, is it not?

Deposition of Herbert C. Hoover.

A. Yes, I am the managing director of that company.

X-Q. 54. How would you describe his position in that company?

A. He acted as the engineer in London for that company, jointly with others, during the short time he remained in this country.

X-Q. 55. Would you describe his position as that of consulting engineer?

A. I should consider that his business was such, although I do not know that he had any precise title.

X-Q. 56. Have you read the record of the defendant in this suit?

A. I have not.

Cross-examination closed.

Deposition closed.

H. C. Hoover.

At the request of counsel for complainants the Commissioner marks for identification the document produced when X-Q. 31 was asked of the witness, as "Zinc Corporation Table."

Adjourned to Friday, the 16th of August, 1912, at 2 o'clock in the afternoon, at the same place.

Deposition of Arthur H. Higgins.

London, August 17th, 1912.

Met pursuant to adjournment. Present, counsel as before.

A. HOWARD HIGGINS, a witness produced on behalf of defendant, having been duly cautioned and sworn, testifies as follows:

Direct Examination by Mr. Scott.

Q. 1. What is your name, age, residence and occupation?

A. Arthur Howard Higgins; 31; "Estrella," Hale Lane, Mill Hill, London, N. W.; metallurgist.

Q. 2. When did you first become engaged in research relative to oil flotation processes?

A. In December, 1903.

Q. 3. At that time, I believe, you were occupied with the Cattermole process, in which the object is to separate the oiled particles by permitting them to settle or be precipitated?

A. Yes, and also with the Froment process.

Q. 4. What was the purpose or object of your investigation of the Cattermole process?

A. Chiefly making tests on ores to find the applicability of the process to them.

Q. 5. Was the Cattermole process owned by the people who engaged you at the time that you first took it up?

A. I do not know.

Deposition of Arthur H. Higgins.

Q. 6. At this time, I believe, you were engaged by Messrs. Sulman & Picard; is that correct?

A. I was.

Q. 7. And afterwards, I believe, you entered the employ of Minerals Separation, Ltd.?

A. That is so.

Q. 8. About how long were you occupied with the Cattermole process while in the employ of Messrs. Sulman & Picard before entering the employ of Minerals Separation, Ltd.?

A. About six months.

Q. 9. Can you remember approximately the date on which you entered the employ of Minerals Separation, Limited?

A. I cannot. When I was employed by Sulman & Picard, Mr. Ballot was there and approved the appointment. My work was in connection with Minerals Separation work entirely, so that the change of employment was nominal rather than actual.

Q. 10. In a general way, what was the nature of your first research or experiments in connection with the Cattermole process?

A. I was first instructed in the use of this process, and afterwards assisted Mr. Chapman in testing ores to find the applicability of the process to them.

Q. 11. With what sort of success was the Cattermole process applied to the ores upon which you experimented?

A. I remember several successes, and only one failure.

Deposition of Arthur H. Higgins.

Q. 12. Did you investigate the cause of failure in that instance?

A. The cause of the failure was due to the large amount of soluble carbonate contained in the ore.

Q. 13. And what effect did this soluble carbonate have?

A. It prevented granulation.

Q. 14. By granulation I presume you refer to the agglomerating or adhering together of small particles to form larger particles?

A. Not entirely. A granule is something more than an agglomerate, being a hard, more or less rounded mass, whereas an agglomerate is not necessarily rounded.

Q. 15. I presume the presence of carbonate incidentally has the effect of causing the consumption of a larger amount of acid than otherwise would have been the case?

A. Certainly.

Q. 16. But even when large amounts of acid were used, still the desired granulation did not take place?

A. Yes, that is so, by reason of the amorphous precipitates produced, absorbing oil in preference to the sulphides.

Q. 17. The amorphous precipitates of what?

A. Such bases as were present in the carbonate, calcium, manganese, and iron.

Q. 18. In what manner was the mixture of ore, water, oil and mineral acid agitated in these experiments?

Deposition of Arthur H. Higgins.

A. In what was commonly known as a gabbet mixer. A further agitation took place in a modified gabbet mixer, that is to say, the baffles were removed.

Q. 19. As I understand your answer, together with my information on this subject, in the Cattermole process a quite violent agitation was first used for the purpose of bringing the oil into intimate contact with the metalliferous particles, after which a more gentle agitation was used for the purpose of promoting granulation of the metalliferous particles; am I correct in this?

A. No, the violent agitation produced incipient granulation, and the more gentle agitation afterwards perfected the granulation. The size of the granules depends on the nature and duration of this second agitation.

Q. 20. At about what period of your engagement upon this work was this, what I may term two-stage agitation, adopted?

A. It was in use when I was instructed in the process by Messrs. Sulman & Picard.

Q. 21. And was this two-stage agitation adhered to in the subsequent practice of the Cattermole process?

A. It was.

Q. 22. Was it considered the best way of carrying out the Cattermole process?

A. Yes.

Q. 23. In the Cattermole process I presume different results were secured with different oils or fatty matter, or that different oils and fatty matter had to be used in different quantities or in a different way?

A. Yes, different oils and mixtures of oils were used. I believe also in different ways and very slightly different quantities.

Q. 24. About what was the range of quantities of different oils found necessary and advantageous?

A. In general we used 5 per cent. of oil on the mineral, which was increased perhaps to six or seven per cent., and decreased to three or four per cent.

Q. 25. In order to make the record perfectly clear to any one not accustomed to this terminology, please state whether by the word mineral you refer to the entire body of ore being treated, or to the metalliferous constituents which it was desired to separate from the ore?

A. I refer to the metalliferous constituents.

Q. 26. Will you compare the degree or kind of agitation to which the mixture of ore, oil, water, and acid is subjected in the first part of the Cattermole process, with the agitation employed when it is desired to float the metalliferous constituents according to the operations referred to in United States patent 835,120, involved in this suit?

A. The degree of agitation in the Cattermole process is not quite so violent as that used in the process referred to in the patent in suit, if the results are to be expected in the same time. If you use the same degree of agitation the results in the process of the patent in suit require longer time for their production than is the case in the Cattermole process.

Q. 27. When did you first learn of the use of oils or

Deposition of Arthur H. Higgins.

fatty matter in connection with the flotation of part of the constituents of an ore?

A. As far as I remember, I was instructed in this by Messrs. Sulman & Picard about December, 1903, and January, 1904. This does not include the Elmore buoyancy process.

Q. 28. You had heard of the Elmore process at an earlier date?

A. I was instructed in the essentials of the Elmore process whilst at the Royal School of Mines.

Q. 29. You are a Fellow of the Royal School of Mines, are you not?

A. There is no Fellowship. I am an Associate of the Royal School of Mines.

Q. 30. What was the occasion of Messrs. Sulman & Picard instructing you in December, 1903, and January, 1904, in the use of oils or fatty matter for flotation of part of the constituents of an ore?

A. I believe it was simply to give me all the information they had on oil processes.

Q. 31. And what information did they impart to you at that time?

A. As far as I remember, it was an alternative to the Cattermole second agitation, and consisted in the use of gas or air, introduced or generated in the pulp containing the agglomerations or imperfectly granulated mineral, for the purpose of bringing this up to the surface as a scum.

Q. 32. Did you do any work along this line at that time?

Deposition of Arthur H. Higgins.

A. Not very much. I do not remember any specific tests.

Q. 33. Do you remember whether Messrs. Sulman & Picard's instructions were represented to you as ideas of their own, or of others?

A. At that time they were not identified.

Q. 34. During your research in connection with the Cattermole process were any of your efforts directed towards improving that process?

A. Not in actually improving the process, but in improving the application of it, I certainly tried some experiments.

Q. 35. Will you describe in a general way the form of apparatus which you used in first applying the Cattermole process?

A. This apparatus consisted of an ore-chute, feeding into a series of four gabbet mixers, followed by a spitzkasten with cylindrical sides. The pulp, after being agitated, in passing through these four gabbets, passed into the spitzkasten, where the separation of gangue slimes from the remainder was effected. The remainder passed into two succeeding gabbet mixers, running at lesser speed than the previous four, where the granulation was perfected. The pulp then passed into another cylindrical spitzkasten, where the gangue was washed away in the overflow, and the granules fell out in the underflow.

Q. 36. About what time was it that you entered the employ of Messrs. Sulman & Picard, that is, what year?

A. Towards the end of December, 1903.

Deposition of Arthur H. Higgins.

Q. 37. Did you find this apparatus which you have described in answer to question 35, constructed and in use at the time you were engaged by Messrs. Sulman & Picard, in December, 1903?

A. I did.

Q. 38. Were there baffles in the first set of four gabbets, and also in the second set of two gabbets referred to in your answer to question 35?

A. There were baffles in the first four mixers, but none in the last two, that is, the fifth and sixth mixers.

Q. 39. When did you first learn of the Froment process, which you have mentioned?

A. I think this was early in 1904.

Q. 40. And how did you learn of the Froment process, that is, through whom, or by what means?

A. There were three pieces of apparatus lying about the laboratory, and I inquired of Mr. Chapman their use. He explained that these were for carrying into effect the Froment process, and briefly explained the process.

Q. 41. Can you at this date give any description of this apparatus?

A. The first piece of this apparatus consisted of a cylindrical vessel, with a small hopper attached to the side of the vessel, the whole capable of holding ten litres or so of water. The vessel contained two stirrers, consisting of short horizontal arms carried on two elliptical frames. The latter could be rotated in opposite directions by means of gearing ending in a handle. The second piece of apparatus consisted of a cylindrical

vessel, with a spout carrying at the bottom a double coiled lead pipe, with perforations. A rake was suspended in this vessel, so that the contents could be stirred. The third piece of apparatus consisted of a wooden box carrying an aluminum sieve and a cam and shaft for agitating the screen. Pipes in this wooden trough allowed the contents of the box to be drawn off at different places.

Q. 42. What sort of experiments did you perform in the way of improving the application of the Cattermole process as referred to by you in answer to question 34?

A. These were chiefly in the use of different oils in different emulsifications. That is all I remember at present.

Q. 43. Were the quantities of oil and acid to be used a subject of interest at that time?

A. I do not remember anything being said about the quantity of oil, except the quantity used was always adjusted to give granulation.

Q. 44. In adjusting the oil to give the best granulation, I presume you experimented with different quantities of oil?

A. Yes, there may have been different quantities, but whenever the granulation became imperfect by reason of the drop in the quantity of oil, the oil was naturally increased.

Q. 45. Did you perform any experiments in connecdon with the Froment process?

A. Yes, one or two, I remember.

Deposition of Arthur H. Higgins.

Q. 46. What apparatus did you use in performing these experiments?

A. The Froment apparatus already described.

Q. 47. You do not remember performing any considerable number of experiments with this apparatus?

A. No, not a considerable number, the results in the few I have mentioned being hopeless.

Q. 48. And after performing these experiments was the Froment apparatus put aside?

A. It was.

Q. 49. Do you remember what finally became of it?

A. I cannot say where it was disposed. It is certainly not in the possession of Minerals Separation, Limited. I have made a search for it recently, and have not found any part.

Q. 50. It undoubtedly has been scrapped?

A. Yes.

Q. 51. Have you any recollection at all as to how long you saw this apparatus around the laboratory?

A. I certainly saw it in the beginning of 1906, but I have no recollection of having seen it since.

Q. 52. I presume you do not know by whose instructions it was destroyed or otherwise disposed of?

A. No, I do not know.

Q. 53. Do you know whether anyone else experimented with the Froment apparatus besides yourself?

A. I never saw anybody do so.

Q. 54. You would probably have seen them if they had experimented with it, would you not?

A. Certainly.

Deposition of Arthur H. Higgins.

Q. 55. By whose instructions, if any one's, did you experiment with the Froment apparatus?

A. These probably came to me through Mr. Chapman, from Messrs. Sulman & Picard.

Q. 56. You do not remember that Messrs. Sulman & Picard themselves personally gave you such instructions?

A. No, my memory is that Mr. Chapman gave me these instructions.

Q. 57. Do you remember whether you had a request or instructions from anyone to terminate your experiments with the Froment apparatus?

A. No, I remember no instructions to terminate this work. It is possible that it was interfered with by other work.

Q. 58. And it is quite probable, I presume, that you exercised your own judgment in the matter of proceeding with the Froment experiments?

A. No, I think I was working under Mr. Chapman's instructions.

Q. 59. What was the first occasion upon which you ever saw part of the constituents of an ore, which, in the form of a pulp, had been oiled, floating upon the surface of the pulp?

A. I cannot state the first occasion, as very small percentages of mineral frequently floated on the surface of the pulp contained in the spitzkasten during the operations with the Cattermole process. I do not think this proportion of mineral ever exceeded 5 per cent. of the whole.

Deposition of Arthur H. Higgins.

Q. 60. With what kinds of oil did you operate, when applying the Cattermole process?

A. Thick residuums, thinner residuums, or thick residuums thinned with lighting oil, oleic acid, and turpentine. That is all I remember.

Q. 61. The residuums you refer to are petroleum residuums, I presume?

A. Chiefly.

Q. 62. Are there any other residuums that you recollect using?

A. Yes, residuum from wood tar distillations.

Q. 63. What was the first occasion upon which you ever saw an oiled concentrate floating upon the surface of a pulp in the form of a scum or froth?

A. I do not understand this question. Do you mean the bulk of the concentrate floating as a scum or froth?

~~A. I do not understand this question. Do you mean the bulk of the concentrate floating as a scum or froth?~~

Q. 64. I mean a considerable proportion of it.

A. With the exception of the floating flocks already described, I saw this phenomenon for the first time whilst carrying out a series of experiments at the instructions of Messrs. Sulman, Picard and Ballot in the early part of March, 1905.

Q. 65. By which of these gentlemen were the instructions given to you?

A ~~R~~. By Mr. Sulman.

Q. 66. Can you state the nature of the instructions?

Deposition of Arthur H. Higgins.

A. These instructions were to carry out a series of tests on the factors influencing granulation.

Q. 67. And while performing these tests did you observe part of the metalliferous mineral floating as a froth or scum?

A. As far as I remember, in the bulk of these experiments there was a small quantity of floating mineral. This only reached appreciable proportions when the reduction of oil was carried down to very small proportions.

Q. 68. I presume the quantity of floating material increased gradually as the quantity of oil was reduced?

A. No, my impression is the quantity of floating material increased rapidly when the oil was reduced below a certain point.

Q. 69. And what was the certain point at which the rapid increase took place?

A. .62 per cent. of the oleic acid on the ore.

Q. 70. Is this report which you have referred to the original record that you made of your investigations, or was it preceded by some record made by yourself personally, and not typewritten?

A. This is the original record, made in my handwriting.

Q. 71. Then it was not preceded by any other memoranda on the subject?

A. It was preceded by no written report or memoranda. The facts contained in this report had been orally reported both to Messrs. Sulman and Picard and Mr. Ballot.

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Q. 72. You mean that prior to your oral report you had made no laboratory memorandum or notation whatever of the percentage of oil and of the result secured?

A. No, I do not mean that. I used to keep a rough record of the experiments, which never left my possession.

Q. 73. What did you do when you first tried your experiments with oil and reduced in quantity to .62 per cent. on the ore; I mean, did you immediately make your oral report that you had referred to to Messrs. Sulman, Picard and Ballot?

A. I called in Mr. Ballot to see one of these experiments performed, wherein froth was produced, but I cannot say which one it was. I may, therefore, have tried a further reduction of oil before making an oral report on it.

Q. 74. You recognized that the formation of this froth was not conducive to the granulation desired in the Cattermole processes, of course?

A. I recognized that this froth was different from the Cattermole process, and could not, therefore, be considered either detrimental or advantageous to granulation.

Q. 75. Did you call in Messrs. Sulman, Picard and Ballot immediately or very soon after your experiment with the oil reduced to the nieghborhood of .62 per cent?

A. I cannot state the interval of time which elapsed between the performance of this experiment and the

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calling Mr. Ballot. It is possible that I made certain that this froth production was not accidental, and then called Mr. Ballot to see it.

Q. 76. Do you remember whether you noticed the appearance of the tailings when the froth was produced, for the purpose of forming an idea as to how complete a recovery was effected by the froth?

A. I feel certain I should do so.

Q. 77. And from the conditions of the tailings I presume you noticed that the recovery was quite high?

A. I did.

Q. 78. Did you before calling in Messrs. Sulman, Picard and Ballot remove any of the froth by spooning or skimming?

A. I should probably have removed some of this froth and examined it to judge its value.

Q. 79. What apparatus was used by you in your experiments in which you reduced the oil to the neighborhood of .62 per cent.?

A. I was using a single gabbet.

Q. 80. And when did the subject first come up of devising other apparatus for the purpose of continuing the investigation along the same lines?

A. I do not remember being consulted on this point.

Q. 81. What was the first apparatus that you saw designed especially for the purpose of separating the metalliferous mineral in the form of a froth?

A. I presume you mean the first apparatus for carrying out this process in a continuous manner. This consisted of a series of gabbet mixers for the agitation,

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and a compound spitzkasten, such as is described in the patent in suit, for the separation.

Q. 82. How did this apparatus, referred to in your last answer, compare in the production of a froth with the operation of the apparatus in which you first produced a froth?

A. The production was equally satisfactory. The separation of the froth, however, in the spitzkasten was not quite so complete as the apparent separation in the single gabbet on stopping the cone.

Q. 83. I do not quite follow the distinction you draw between the production of the froth and its separation. Will you kindly explain?

A. The froth is produced in the liquor during the agitation, and is naturally mixed with the gangue The formation of froth is not evident except from an indication known as the "clean-up." This can, of course, be made evident by stopping the agitation, when the froth is allowed to separate from the gangue. The operation of separation I refer to is the actual act of separating the froth so formed from the remainder of the pulp.

Q. 84. And this act of separation, which I understand to be the actual stratifying or separating of the froth and gangue into separate layers, is what you referred to as not being so satisfactory in the spitzkasten of the continuous machine as in the single gabbet with which you first experimented?

A. I did not refer to the actual stratifying, but rather to the separation of the different strata.

Q. 85. And it was this separation of the different strata that was not quite so complete in the continuous apparatus as with the single gabbett with which you first experimented?

A. That is the meaning I intended to convey.

Q. 86. What took place in the spitzkasten of the continuous machine?

A. The pulp on reaching the water surface separated into a layer of froth which floated away over the discharge end of the spitzkasten. Owing to the fact that as the spitzkasten increased in width as it increased in length, a certain amount of expansion of the froth took place, which allowed some of the mineral contents to fall out. This obviously increased the mineral in the tailings. The tailings sank through the water and were drawn off at the points of the spitzkasten.

Q. 87. After this first continuous apparatus was built and operated, was another apparatus designed for continuous operation constructed?

A. I believe so. I left England for South America in the spring of 1906, and as far as I remember this apparatus was in use when I left. When I returned, about a year later, a different type of spitzkasten was in use.

Q. 88. In the first continuous-operation apparatus was the pulp discharged from the agitator through a pipe upon a shallow trough or apron, over which it flowed to the spitzkasten?

A. It was.

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Q. 89. Was this same arrangement present in the apparatus which you saw upon your return from South America?

A. So far as I remember, there was a launder also in that apparatus, carrying the pulp to the spitzkasten, which were rectangular or square, instead of increasing in width with length.

Q. 90. Do you remember any difference in the proportions of the apron or launder in the first continuous-operation apparatus and the proportions of the launder in the apparatus which you saw on your return from South America?

A. I have only an imperfect recollection of this plant. I saw it in operation on my return from South America, I believe previous to taking a short holiday, and I am under the impression that this plant was dismantled before I saw it on a second occasion.

Q. 91. After you had performed your experiments with the quantity of oil reduced to the neighborhood of .62 per cent. on the ore, and had noticed from the appearance of the tailings that the recovery in the froth was quite high, did it occur to you that a process of concentration might be carried out by separating this froth?

A. I was certain of it.

Q. 92. And did Messrs. Sulman, Picard and Ballot agree with you in that?

A. Undoubtedly. I remember Mr. Ballot was particularly enthusiastic.

Adjourned to Monday, the 19th of August, 1912, at 10:30 A. M., at the same place.

Deposition of Arthur H. Higgins.

LONDON, August 19th, 1912.

Met pursuant to adjournment. Present, counsel as before.

Direct examination of Arthur Howard Higgins continued:

Q. 93. In operating the Cattermole process, did you employ the two-stage agitation both when the oil was directly added and when the oil was formed by the action of a mineral-acid upon soap, that is, formed *in situ?*

A. Yes.

Q. 94. About what length of time did each stage of the Cattermole agitation occupy?

A. The time varied as the state of crushing of the ore. In the plant already described, the first agitation, that is, the agitation given in the first four mixers, was supposed to occupy five to eight minutes, whilst the second agitation in the last two mixers, three or four minutes.

Q. 95. Was the instruction given you regarding the Froment process, and your trials of that process in the Froment apparatus, among the first things which occurred after your engagement by Messrs. Sulman & Picard upon the work of Minerals Separation, Ltd., late in December, 1903?

A. The instructions in the method of operating the Froment process, I think I had early in 1904. The tests I referred to were certainly in 1904, and, as far as I remember, a little later than the instructions.

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Q. 96. Is there any memorandum which you made and can refer to for the purpose of fixing the date when you made the tests with the Froment apparatus?

A. I fix these by the date of an incident.

Q. 97. My question was directed more particularly to ascertaining whether you can fix more definitely the date of your tests of the Froment apparatus?

A. I am confident that I had been instructed in the principles of the Froment process before the Minerals Separation laboratory was removed from Messrs. Sulman & Picard's, at 44 London Wall, to Aldermanbury avenue, whilst the tests I referred to were, in my recollection, carried out in the latter place.

Q. 98. I notice that the occupancy of the Aldermanbury avenue laboratory extended over a period of about a year, between the spring of 1904 and June, 1905. Can you not by some means fix the date of your tests of the Froment apparatus more definitely than simply as having taken place during the occupancy of the Aldermanbury avenue laboratory?

A. As far as I remember, these tests were done in May or June, 1904.

Q. 99. Do you remember having made any formal or written report that would show the precise date when you tested the Froment process in the Froment apparatus?

A. No. At that time a good many failures were only reported orally.

Q. 100. Do you remember when you first learned that the Froment process was patented?

Deposition of Arthur H. Higgins.

A. I think in 1904, previous to the removal of the laboratory.

Q. 101. What kind of ore did you use in testing the Froment apparatus?

A. Copper ore containing gold and carrying probably 10 per cent. of soluble carbonates.

Q. 102. That is, the soluble carbonates occurred naturally in this ore?

A. Yes.

Q. 103. Where did this ore come from, that is, what mine or locality?

A. It is known as Nagyag. It came from either Austria or Hungary. Hungary, I believe.

Q. 104. Did you try any other ore by the Froment process in the Froment apparatus?

A. I do not remember any.

Q. 105. Did you try the Froment process, using any other apparatus than that sent to Minerals Separation by Mr. Froment?

A. Yes. I made experiments in test tubes, and in the gabbett.

Q. 106. What kind of oil did you use in operating the Froment process?

A. I think I tried the same oils as we used for the Cattermole process.

Q. 107. The same oils as are referred to by you in answer to question 60?

A. Yes.

Q. 108. Is lighting oil practically the same as what is often termed "kerosene"?

A. Yes.

Q. 109. In your report, which has been marked for identification as "Higgins' Report, March 16, 1905," you state that a diminution of the percentage of oil when that oil is either paraffine or Balkhany crude oil does not cause a similar frothing to the oleic acid. Have you since found it possible to use other oils than oleic acid with the result of producing a froth?

A. Yes.

Q. 110. What other oils?

A. I have obtained satisfactory results by the use of petrol, certain portions of the distillate of crude petroleum, such as cosmos oil, vegetable oils, such as palm oil, cottonseed oil, linseed oil, and animal oils, such as lard oil, and oil squeezed from beef fat.

Q. 11. Have you been successful in the use of eucalyptus oil?

A. Yes.

Q. 112. Is the petrol to which you refer the distillation product of petroleum, sometimes known as "gasolene"?

A. The petrol I refer to is one of the lightest constituents of crude petroleum. I do not know whether gasolene is the same material.

Q. 113. The petrol you refer to is the distillation product commonly used in internal combustion engines, such as automobile engines, is it not?

A. Yes, it is known as .680 spirit.

Q. 114. Is the "paraffine" referred to in Higgins' Report, March 16, 1905, the same as lighting oil or kerosene?

A. Yes.

Q. 115. In using these different oils in the operations set forth in the patent in suit, do you find it necessary in treating the same ore to use different quantities of these oily substances?

A. Referred to the same ore, the quantity used is generally the same, but referred to different ores, the quantity may be different.

Q. 116. Do you mean that in treating the same ore you use the same quantities of all of the different oils referred to?

A. I mean the same results can be obtained by the use of the same quantity, but commercial consideration frequently causes one oil to be used in less quantity than another.

Q.117. Can you state what the smallest quantity is of eucalyptus oil that will produce a froth, operating upon, say, some one of the Broken Hill ores with which you have experimented?

A. The smallest quantity of eucalyptus which I have found in my experiments on Broken Hill ore to give a satisfactory concentration as a froth, is half a pound to the ton of ore.

Q. 118. Would you obtain equally good results on that same ore using one-half pound of Cosmos oil?

A. Speaking from memory, I believe the results on Cosmos oil may have been a little lower when such a quantity of oil was used.

Q. 119. Will Cosmos oil in any quantity give as good a recovery as eucalyptus oil?

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A. Yes, I think so.

Q. 120. You would have to use more of the Cosmos oil than eucalyptus oil?

A. I am not certain that I should do so. I have not made comparative experiments with these two oils, and it is possible that the same results might be obtained in different periods of time for the agitation.

Q. 121. What is Cosmos oil, that is, what is its origin, and what is it used for?

A. It is a petroleum distillate, sold for lubricating purposes.

Q. 122. Is it what is sometimes called cylinder oil?

A. I do not know. I think it is more in the nature of a valve oil.

Q. 123. Is the Cosmos oil the Standard Oil Company's Cosmos oil?

A. Yes, the samples were obtained from their London firm, The Anglo-American Oil Company.

Q. 124. Of what oil can you use the smallest quantity in carrying out the operations of the patent in suit, and of what oil is it necessary to use the largest quantity, in your experience?

A. Generally, I should expect the least quantity of oil to be one of the thinnest of oils, and the biggest quantity a thick oil, that is, referring to the same time for the agitation.

Q. 125. Referring to the continuous-operation apparatus which you saw upon your return from South America, do you remember seeing any later continuous-operation apparatus constructed and operated after that one, that is, in London, I mean?

A. Yes.

Q. 126. In what laboratory was the apparatus which you saw on your return from South America; that is, where was the laboratory located?

A. In Charlotte street.

Q. 127. Do you know why this particular apparatus was dismantled before you saw it a second time?

A. No, that was determined by Mr. Theodore J. Hoover.

Q. 128. Where and when did you see the next continuous-operation apparatus?

A. In the same building at a later date. I am not certain as to the date when this apparatus was actually installed, but I remember it was in running condition when I left for Australia in August, 1908.

Q. 129. In what respect was this apparatus different from the one you saw on your return from South America?

A. Chiefly in size.

Q. 130. Do you know whether the Nagyag ore is now being treated by a flotation process?

A. I do not.

Q. 131. You do not know that it is being so treated, or that it is not being so treated?

A. I do not know that it is being treated.

Q. 132. Did you ever experiment with flotation of the Nagyag ores other than in connection with the Froment process?

A. I do not remember having done so.

Q. 133. Have you any personal knowledge of Min-

Deposition of Arthur H. Higgins.

erals Separation ever having successfully treated the Nagyag ores by the operations set forth in the patent in suit?

A. I have no personal knowledge of such operations.

Q. 134. Did the apparatus constructed after the one you saw on your return from South America differ from the preceding one in any other respects than size?

A. My recollection of the apparatus in use when I returned from South America is somewhat scanty, and I am therefore unable to compare it in detail with the later apparatus mentioned.

Q. 135. Can you describe the later apparatus, and if so, will you?

A. The apparatus consisted of a hopper to feed ore into a series of mixers, consisting of boxes about 14 or 15 inches square, and about 3 feet deep. There were, I believe, seven of these. Water, oil, acid and steam could be fed into any one desired, and arrangements were made for drawing off the pulp from any one of them. The separating apparatus consisted of four spitzkasten, square in section, having an apron or launder, such as is shown in the patent in suit. There were filters and settling tanks for the concentrates and tailings, with pumps and pipes for the return of the liquor to a head tank.

Q. 136. What kind of apparatus did you see in Australia for carrying out flotation operations?

A. A series of mixers for the agitation, six in num-

ber, of which five were in general use. The ore was fed into these mixers from a hopper, in which water was added. Sulphuric acid and steam were fed into the first agitator box. Oleic acid was fed into the second box, and the agitation continued in these boxes until No. 5 was reached, where additional acid could be added if desired, before the discharge of the pulp into a launder. The launder delivered the pulp into a spitzkasten, where a considerable amount of thick froth was removed as an overflow, the remainder passing out as the underflow into a second launder, which carried the material to a second spitzkasten. Here more froth was removed as an overflow, and the tailings, or underflow, discharged into a launder carrying them to a third spitzkasten. There were two sections so described. The underflow from the third spitzkasten of both sections ran into a common sump, from which they were taken by an elevator to a fourth spitzkasten, from which the final froth was taken, the tailings passing to settling tanks. The combined concentrate ran into a settler, consisting of a large hopper, over which sprays of water were adjusted. These sprays of water caused the bulk of the froth to break up and so discharge the bulk of its contents. These were removed at the bottom of the hopper. The overflow, carrying some mineral and a good deal of gangue slime, passed at one time into a special sump, where a good deal of impure concentrate was collected. This impure concentrate was fed back to the plant at intervals. The liquor, after passing through this special sump, still contained

some mineral and gangue slime, and passed to the pump sump, from which it was returned to the hopper, previously mentioned, in which water was added to the feed.

Q. 137. What ore were you using when you made your experiments for the purpose of ascertaining the effect of varying the quantity of oil upon granulation?

A. Broken Hill crude ore, obtained, as far as I know, from the Central mine.

Q. 138. What is the nature of your present duties for Minerals Separation, Limited?

A. Testing, or supervising testing, operations on samples of ores, to find the applicability of the different Minerals Separation processes to them; also experimental work in improving processes.

Direct examination closed.

Cross-Examination by Mr. Williams.

X-Q. 139. In Q. 66 you were asked as to the nature of instructions received by you, and in your answer to Q. 67 you speak of the reduction of oil being carried down to a very small proportion, and in Q. 137 this work, I take it, was referred to as experiments for ascertaining the effect of varying the quantity of oil upon granulation. Please state as accurately as you can what were these instructions, so far as they related to the quantity of oil.

A. As far as I remember, the instructions were to start with large quantities of oil, say the upper limit of Cattermole's specified quantity, and reduce this as far as possible. In other words, to find the lowest limit at which any result could be obtained by the use of oil.

Deposition of Arthur H. Higgins.

X-Q. 140. And how far, in fact, did you, in carrying out these instructions, reduce the quantity of oil?

A. 0.1 per cent. is the lowest quantity of oil I reported as having used, although the absolute vanishing point, where no oil was used at all, was tested.

X-Q. 141. You have referred to some floating material appearing at times in your work on the Cattermole process prior to March, 1905. Was this deemed an advantage or a disadvantage in that process?

A. It was deemed such a disadvantage that I arranged a piece of apparatus on the plant, which I called an "air-trap," to separate these floating flocks from the pulp before entering the spitzkasten. The flocks so separated were passed to the fifth mixer, where they were destroyed.

X-Q. 142. Your answer to Q. 60 is not quite clear to me in its reference to oleic acid. Please explain a little more fully what use was made of oleic acid in the Cattermole process.

A. Oleic acid was used as soap, that is, its sodium or potassium salts, in forming the emulsions used in the Cattermole process; also as an oil emulsified with soap, and later as a solution of soap. In addition, it was also used as oleic acid itself, without emulsification or solution as soap.

X-Q. 143. In your Report of March 2, 1905, in the first paragraph thereof, you speak of other conditions which suggested to you their importance in altering the time of granulation. What, if you remember, were these other conditions?

Deposition of Arthur H. Higgins.

A. I believe one of these conditions referred to the relation between the size of the cone, and the mixer or jar forming the gabbett. I think the others were of little importance, as far as I remember. One was the use of insoluble soaps in granulation.

X-Q. 144. About what was the mineral-content, that is, the metalliferous mineral-content, of the Broken Hill ore which you were using in these tests wherein froth production first appeared?

A. The mineral content formed roughly 50 per cent. of the ore.

X-Q. 145. After the froth had been produced in the single gabbett, what was done to remove it or separate it?

A. Mr. Ballot desired to know the weight of the froth and requested me to remove it by introducing a long-stemmed funnel and by pouring water down the funnel, causing the froth to overflow the top of the gabbett into a basin placed beneath. Experiments were also made in scooping this out with a spoon, and later the pulp was discharged onto a spitzkasten. At an early date Mr. Sulman brought an apparatus that he had had constructed, consisting of a septum passing through the vessel, which could be drawn through when the froth had been formed, and thus remove the froth bodily.

X-Q. 146. In your answer to Q. 17 you refer to certain bases. What minerals were you referring to in that answer?

A. Calcium, manganese and iron are members of an isomorphous group of minerals, anyone of which can re-

place in any quantity any of the others. I was referring to such minerals as would be commonly called "calcite," but which contain iron or manganese, so replacing the calcium in small quantities. These might be termed ferriferous or manganiferous calcite.

Cross-examination closed.

Deposition closed.

London, August 22nd, 1912.

Met pursuant to adjournment. Present, counsel as before.

The Commissioner notes that the letters or reports of Sulman & Picard to John Ballot, dated July 14, 1903; July 27, 1903, and August 11, 1903, were produced upon request of counsel for defendant, and submitted to him for examination, and returned by him.

The Commissioner also notes that all of the documents marked for identification were handed to defendant and his counsel for examination, and copies thereof supplied, as requested.

The defendant closes his case.

Defendant's Exhibit.

Defendant's Exhibit Extract from "Treatise on Chemistry Applied to the Manufacture of Soap and Candles."

FLOTANT SOAPS.

Under this title are designated those soaps which, when in a state of paste, are batted or inflated with air, by which means its buoyancy becomes such, that the soap floats in the water. It is a favorite soap, not only on account of whiteness and mildness, but the facility with which it gives a lather. These soaps are colored and perfumed exactly as are the toilet soaps generally. It must be remarked, however, that the olive, palm, and sweet almond oil soaps are the only ones that can be converted into flotant soaps, it being impossible to inflate those soaps made of suet or lard. They are prepared from either of the preceding soaps, by cutting it into thin shavings and melting over a water-bath, with twelve pounds of water to every fifty pounds of soap. When the mass is in perfect fusion, it is agitated with a twirling fan (Figs. 54, 55), until it froths and foams to the top of the vessel.

Fig. 54.

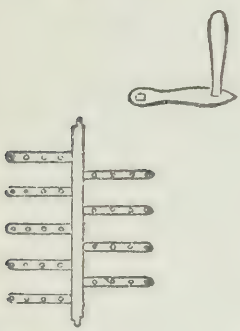


Fig. 55.

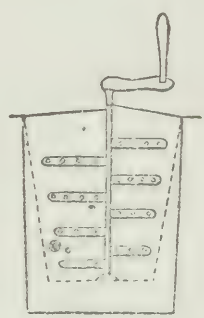
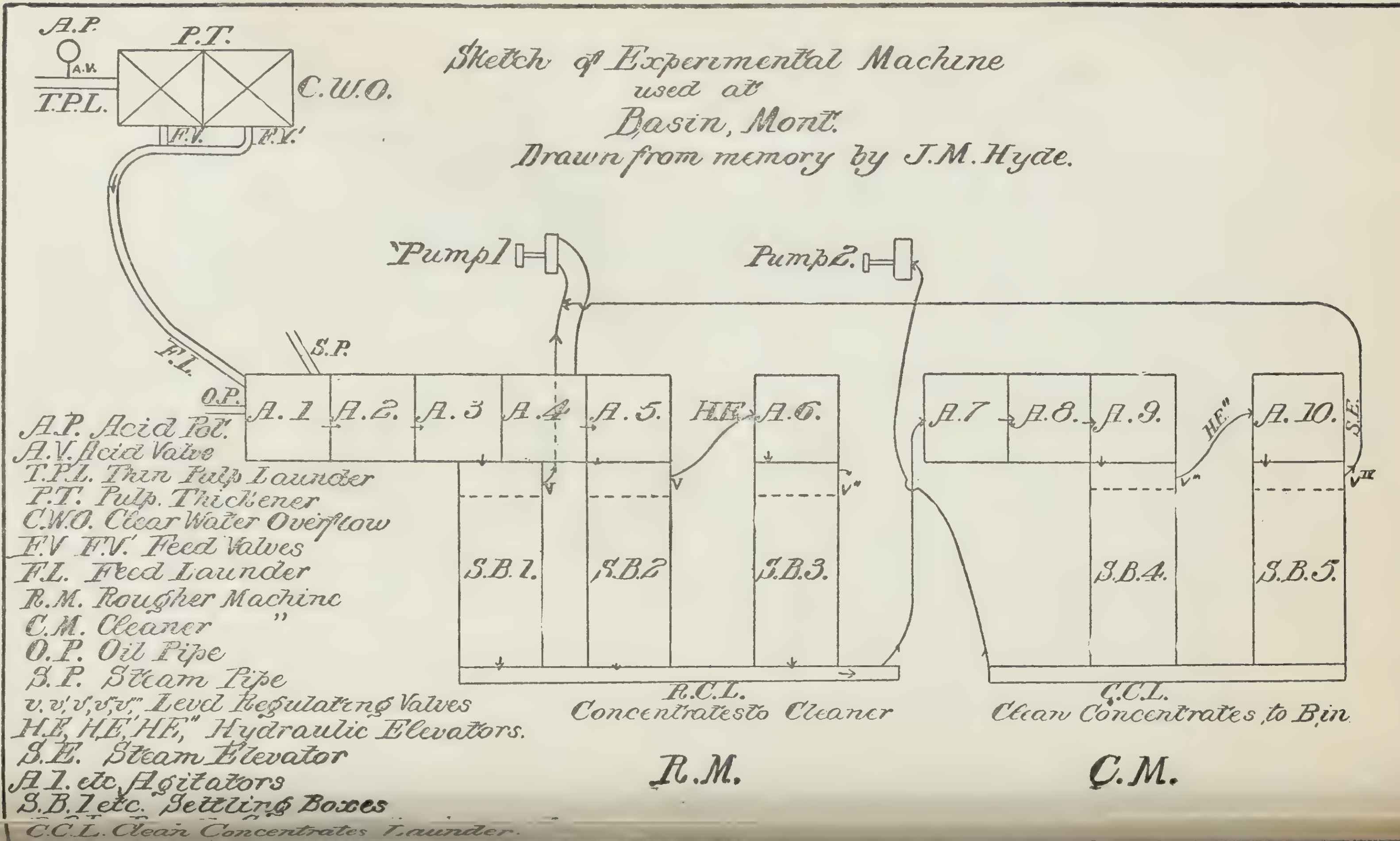


Fig. 54 represents the twirling fan detached from the water bath; it is made to revolve on a pivot, and to be taken on or off at will. After the perfume has been added, the contents are emptied out into cooling frames or moulds.

Defendant's Exhibit Hyde Sketch of Experimental Machine.



Defendant's Exhibit.

Defendant's Exhibit Certified Copy of File-Wrapper and Contents of Cattermole, Sulman & Kirkpatrick-Picard Patent No. 788,247.

UNITED STATES OF AMERICA.

DEPARTMENT OF THE INTERIOR,

UNITED STATES PATENT OFFICE.

To all to whom these presents shall come, Greeting:

THIS IS TO CERTIFY that the annexed is a true copy from the Records of this Office of the File Wrapper and Contents, in the matter of the Letters Patent of Arthur Edward Cattermole, Henry Livingstone Sulman, and Hugh Fitzalis Kirkpatrick-Picard, Number 788,247, granted April 25, 1905, for Improvement in Ore Concentration.

IN TESTIMONY WHEREOF I have hereunto set my hand and caused the seal of the Patent Office to be affixed at the City of Washington, this [SEAL.] 31st day of January, in the year of our Lord one thousand nine hundred and twelve and of the Independence of the United States of America the one hundred and thirty-sixth.

F. A. TENANT

Assistant Commissioner of Patents.

Defendant's Exhibit.

2--437.
Case A

Number (Series of 1900). Div'n. XXV.
Div. 25

200,649 1904 (Ex'r's Book). 8-134

Patent No. 788247

Name Arthur Edward Cattermole, Henry Livingstone Sulman and Hugh Fitzalis Kirkpatrick-Picard.

of London

County of

England

Invention Ore Concentration

Division of App., No. , filed , 190

Parts of application filed.

	Original.	Renewed.
Petition	Mch 29, 1904	, 190
Affidavit	" ", 1904	, 190
Specification	" ", 1904	, 190
Drawing not required	, 190	, 190
Model or Specimen not required	, 190	, 190
First Fee Cash $15.	Mch 29, 1904	, 190
1 " " Cert.	, 190	, 190
Appl. filed complete	Mar. 29, 1904	, 190

Examined Lewis B. Wynne	Feb'y 3d, 1905	, 190
Countersigned J W Babson		, 190
	For Commissioner.	For Commissioner.
Notice of Allowance	Feb. 6, 1905	, 190
Final Fee Cash $20.	Apr. 5, 1905	, 190
" " Cert.	, 190	, 190
Patented		April 25, 1905

Associate Attorney Attorney Knight Bros.

2 City

Name Serial Number

Patent No. Date of Patent

Defendant's Exhibit.

JOINT.
$15.⁰⁰ Received Serial No. 200,649 Paper No. ½
S. Mar 29 1904 APPLICATION.
Chief Clerk. U. S. Patent Office

PETITION.

TO THE COMMISSIONER OF PATENTS.

Your Petitioners ARTHUR EDWARD CATTERMOLE, HENRY LIVINGSTONE SULMAN and HUGH FITZALIS KIRKPATRICK-PICARD, subject of the King of England, and residents of London in England whose Post Office addresses are respectively 10, Woodland Rise, Highgate, London, England, and 44, London Wall, in the City of London, England pray that Letters patent may be granted to them, as joint inventors, for the "Improvements in or Relating to Ore Concentration" set forth in the annexed Specification, and they hereby appoint Knight Bros. of Washington, D. C., a firm consisting of Hervey S. Knight and Harry A. Knight their Attorneys with full power of substitution and revocation, to prosecute this application, to make alterations and amendments therein, to receive the Patent, and to transact all business in the Patent Office connected therewith.

Signed at London England this 16th day of March 1904

Full names of INVENTORS

ARTHUR EDWARD CATTERMOLE
HENRY LIVINGSTONE SULMAN
HUGH FITZALIS KIRKPATRICK-PICARD

Defendant's Exhibit.

To all whom it may concern:

Be it known that we ARTHUR EDWARD CATTERMOLE, HENRY LIVINGSTON SULMAN and HUGH FITZALIS KIRKPATRICK-PICARD, subjects of the King of England, residing at London, England, have invented cer-
Aug. 9/04 tain new and useful "Improvements in ~~or Relating to~~ Ore Concentration" of which the following is a specification:—

Our process has for its object the separation of minerals from the siliceous or earthy matters of ores by means of soaps or similar compounds, and is dependent upon the superior physical attraction exhibited by minerals for fatty or resin acids, or for certain other aromatic derivatives (such as cresols, phenols, etc.) which form soluble salts or compounds with alkaline hydrates, as compared with earthy or siliceous substances.

Insert A Aug. 9/04. In general the soluble compounds we employ are typified by ordinary soaps, from which the fatty or resin acids are liberated by the addition of a suitable mineral acid, and which fatty or resin acids are again rendered completely soluble by the addition of an equivalent of caustic alkali.

In carrying out our invention the suitably crushed ore is suspended in water, and to the mixture an addition of a small quantity of soap solution is made. A small amount of mineral acid is then added, which decomposes the soluble soap or other similar compound by uniting with the alkaline base thereof, thus liberat-

Defendant's Exhibit.

ing in a state of chemical sub-division the fatty or resin acid or other compound such as cresol, etc., in intimate contact with the suspended ore particles. It is found that the liberated acids, etc., which may even be solid under ordinary conditions, are precipitated and adhere to the sulphuretted minerals, or to sulphur, graphite, or free metals present in the ore, leaving the gangue or earthy particles preferentially wetted by water, and free from adhesions of fatty acid and the like.

The fatty acid and the like used for the purpose of adhering to the mineral particles is thus produced in situ throughout the suspended ore mass in the most intimate contact or admixture therewith.

The mineral particles now attached to, or more or less coated or enclosed by, films of fatty or resin acids and the like, are capable of being separated from the gangue or earthy particles by various methods dependent upon this altered physical condition.

For example, the coated mineral particles may be removed by generating gaseous bubbles in the mixture which preferentially attach themselves to the fatty or similar acid-coated particles and raise them to the surface of the pulp, whence they may be removed by skimming or the like. If the ore contain a carbonate, any small excess of the acid used to decompose the soap or similar alkaline compound will also liberate bubbles of carbonic acid, which will attach themselves to the fatty acid coated mineral particles, and float them to the surface; or a suitable carbonate (or other substance capable of liberating a gas on the addition of a suitable

Defendant's Exhibit.

acid, such as an easily decomposible sulphide, etc.,) may be initially added to the ore mass for such purpose.

Or the mineral particles may be caused to adhere to metallic or other suitable surfaces coated with similar fatty acids; or, finally, the coated mineral particles may be caused to adhere to wood, sawdust, or other suitable material lighter than water, coated with similar fatty acids, etc., which can then be removed by flotation; In each case leaving the mineral-free gangue particles capable of rejection.

After separation of the coated mineral particles by any of the methods before mentioned, the recovered mineral concentrate is subjected to the action of a suitable amount of caustic or carbonated alkali, whereby the fatty or resin acid, etc., recombines completely with the alkali, forming a readily soluble soap or alkaline compound; after draining this off, and washing with water, if necessary, the mineral particles are left clean and free from soap.

The resulting solution thus contains all the soap or equivalent compound originally used, in a state ready for immediate employment in the separation of mineral from fresh quantities of ore; and the process becomes completely cyclic with regard to the soap employed.

Throughout the operation the same soap or similar compound is used, the constituent whereof my be quite solid under ordinary conditions, the only additions required being small quantities of mineral acid and alkali

Defendant's Exhibit.

for the decomposition and re-composition of this agent during the cycle of operation.

WHAT WE CLAIM as our invention and desire to secure by Letters Patent is:—

~~1. The herein described process of concentrating ores which consists in mixing the ore pulp with a soap solution and a mineral acid which liberates the organic acid from the soap, and thereafter separating the coated mineral matter from the non-coated gangue.~~

2. The herein described process of concentrating ores which consists in mixing the ore pulp with a soap solution and a mineral acid which liberates the organic acid from the soap, separating the coated mineral matter from the non-coated gangue and adding alkali to the coated mineral matter to reproduce the soluble soap.

~~3. The herein described process of concentrating ores which consists in mixing the ore pulp with a soap solution and a mineral acid which liberates the organic acid from the soap, bringing the liquor into intimate contact with a gas and separating out the coated mineral matter which floats.~~

4. The herein described process of concentrating ores which consists in mixing the ore pulp with a soap solution and a mineral acid which liberates the organic acid from the soap, bringing the liquor into intimate contact with a gas, separating out the coated mineral min-

eral matter which floats and adding thereto an alkali which reproduces the soluble soap.

In testimony whereof we have signed our names to this Specification in the presence of two subscribing witnesses.

Full names	Arthur Edward Cattermole
of	Henry Livingstone Sulman
Inventors	Hugh Fitzalis Kirkpatrick-Picard

2 Witnesses.

F. B. Buss.

Frederick Read.

Oath.

London }
England } SS.

Arthur Edward Cattermole, Henry Livingstone Sulman and Hugh Fitzalis Kirkpatrick-Picard the above named petitioners, being dully sworn, depose and say that they are subjects of the King of England and residents of London, in England, ; and that they verily believe themselves to be the original, first, and joint inventors of the "Improvements in or Relating to Ore Concentration" described and claimed in the annexed Specification; that they do not know and do not believe that the same was ever known or used before their invention or discovery thereof; or patented or described in any printed publication in any country before their invention or discovery thereof, or more than two years prior to this application; or patented in any country foreign to the United States on an ap-

plication filed more than twelve months before this application; or in public use or on sale in the United States for more than two years prior to this application; and that no application for patent on said improvements has been filed by them or their representatives or assigns in any country foreign to the United States, except as follows: Great Britain No. 17109, dated 6th August, 1903.

ARTHUR EDWARD CATTERMOLE
HENRY LIVINGSTONE SULMAN
HUGH FITZALIS KIRKPATRICK-PICARD

[Revenue Stamp.]

Sworn to and subscribed before me this 16 day of March, 1904 by all three Deponents.

G F WARREN

(Notarial Seal) Notary Public

CONSULATE-GENERAL OF THE UNITED STATES OF AMERICA FOR GREAT BRITAIN & IRELAND AT LONDON

I, Richard Westacott Acting Consul-General of the United States of America at London, England do hereby make known and certify to all whom it may concern that George Frederick Warren who hath signed the annexed Certificate, is a Notary Public, duly admitted and sworn and practising in the city of London, aforesaid, and that to all acts by him so done full faith and credit are and ought to be given it Judicature and thereout.

Defendant's Exhibit.

In Testimony Whereof, I have hereunto set my hand and affixed my Seal of Office at London aforesaid, this 18th day of March in the year of our Lord One Thousand Nine Hundred and Four

RICHARD WESTACOTT

(Consular Seal) Acting Consul-General.

2–260

M. E. C.

Div. 25 Room 15 Paper No. 1

Address only "The Commissioner of Patents, Washington, D. C."

All communications respecting this application should give the serial number, date of filing, and title of invention.

DEPARTMENT OF THE INTERIOR

UNITED STATES PATENT OFFICE

WASHINGTON, D. C., April 29, 1904.

MAILED " " "

CATTERMOLE ET AL.,
Care Knight Bros.,
Washington, D. C.

Please find below a communication from the EXAMINER in charge of your application. #200,649, filed March 29, 1904, for Ore Concentration.

F. I. ALLEN.

Commissioner of Patents.

Defendant's Exhibit.

It is suggested that "or relating to" be canceled from the title as surplusage.

The 1st claim is rejected in view of 228,004, Tunbridge, May 25, 1880, Washers, H. See line 45 of Tunbridge's specification.

Claim 2 appears to express novel subject matter. There is not, however, a proper line of division between the claims of this application and those of applicant's companion case, serial number 200,650. This companion case is so ~~clearly~~ closely related to this that applicants will be required to insert a cross reference thereto, giving serial number and filing date.

Claim 3 is rejected in view of Tunbridge, cited, and e. g., British patent 12,778, Lake, June 4, 1902, Washers, H.

Claim 4 appears allowable.

LEWIS B. WYNNE
Examiner.

T. F. Mitchell

Division XXV.

Defendant's Exhibit.

Serial No. 200,649 Paper No. 2
Filed 190

Application Room
Aug 9 1904
U. S. Patent Office

Patent Office,
Aug 10 1904
Division XXV.

Room No. 315.

AMENDMENT.

Inventors: Arthur Edward Cattermole.
Henry Livingstone Sulman.
Hugh Fitzalis Kirkpatrick Picard.
Invention: Ore Concentration.
Filed March 29, 1904. Serial No. 200649.

HON. COMMISSIONER OF PATENTS,

Sir:—

The above named application is hereby amended as follows:

Cancel the words "or relating to" from the title.

Page 1, at the end of the second paragraph insert:

A *The process described in this application relates to a process somewhat similar to the process described and claimed in a copending application filed by us of even date with this application and serially numbered 200,650.*

Cancel claims 1 and 3 and substitute the following:

Defendant's Exhibit.

S B c. 1/04 1 1. The herein described process of concentrating ores which consists in mixing the ore pulp with a soap solution and a mineral acid so as to liberate from the soap the organic acid which coats the desired mineral particles and not the gangue, and thereafter separating the coated mineral matter from the non-coated gangue.

Su B' c. 1/04 2 3. The herein described process of concentrating ores which consists in mixing the ore pulp with a soap solution and a mineral acid so as to liberate from the soap the organic acid which coats the desired mineral particles but not the gangue bringing the liquor into intimate contact with the gas and separating out the coated mineral matter which floats.

Remarks.

Tunbridge's process is not for ore concentration but for collecting metals suspended in waste waters. Tunbridge does not propose to separate minerals from ores and does not describe any method for doing so.

Applicants' process on the contrary is one by which metalliferous matter is separated out from the gangue with which it is associated in ores.

Tunbridge has not discovered that fatty acids have a preferential affinity for metalliferous matter over gangue and his process does not in any way depend upon such preferential affinity.

The Applicants have discovered that such fatty acids adhere to metalliferous matter, sulphuretted minerals, sulphur, graphite, or free metals leaving the gangue

preferentially wetted by water and free from adhesions of fatty acid and the like; and their invention consists in liberating throughout an ore pulp a fatty or resin acid in such a state of chemical subdivision in intimate contact with the suspended ore particles so that the preferential affinity can be exercised.

Tunbridge deals with waste waters containing say gold in suspension. He captures that gold by forming in the water a coagulum which retains all the solid matter in suspension. It is to be noticed that this coagulum would collect solid matter quite irrespective of its nature and if Tunbridge's process were applied to an ore pulp both the metalliferous matter and gangue would be enclosed in the curd or coagulum and no separation would be effected.

In the Applicants' process on the other hand the whole object is separation, and the liberated fatty acid does not form a coagulum and does not adhere to the gangue but merely forms a thin coating on the particles of metalliferous matter and the like enabling these particles to be separated from the gangue or earthly particles by various methods depending on its altered physical condition as by flotation by gaseous bubbles.

Tunbridge forms his coagulum in the soapy water by either using hard water or by adding some substance, preferably sulphate of lime to cause the soap to form a curd. Even supposing some fatty acid were liberated in Tunbridge's process it would all be included in the curd and could not exercise a preferential affinity.

Defendant's Exhibit.

The Applicants' object is not to make a curd and they do not use sulphate of lime. Their object is first to liberate the fatty acid and afterwards to saponify it again.

It is respectfully submitted that Tunbridge's specification does not in any way suggest the Applicants' method of separating metalliferous matter from gangue by the preferential affinity of fatty acids.

LAKE (FROMENT) BRITISH PATENT No. 12778/03.

This specification discloses the use of a gas to separate "oily" metalliferous matter from gangue by flotation but Froment has not recognized the selective power of fatty or resin acids and he has not discovered that the acid liberated from soap or the like will first coat the metalliferous particles in preference to gangue and will enable the particles to adhere to gaesous bubbles and be separated by flotation.

The Applicants do not attempt to claim the flotation process broadly, but claim 3 is for the combination of the fatty acid selection with the separation by flotation.

Respectfully submitted,

KNIGHT BROS

Attorneys.

WASHINGTON, D. C.,
August 5, 1904.

Defendant's Exhibit.

M. E. C.
Div 25 Room 15 2–260. Paper No 3

Address only "The Commissioner of Patents, Washington, D. C."

All communications respecting this application should give the serial number, date of filing, and title of invention.

DEPARTMENT OF THE INTERIOR
UNITED STATES PATENT OFFICE
WASHINGTON, D. C., October 4, 1904.
Mailed " " "

CATTERMOLE, SULMAN AND KIRKPATRICK-PICARD,
Care Knight Bros.,
City.

Please find below a communication from the EXAMINER in charge of your application. #200,649 filed March 29, 1904, for Ore Concentration.

F. I. ALLEN
Commissioner of Patents.

Case as amended and argued August 9, 1904, further considered.

The only distinction of process in the first claim as relates to the prior art (575,669, Robson, Jan. 9, 1897, Washers, H) lies in the particular reagent employed for coating the metallic particles, and perhaps in the particular method of forming the reagent. Applicant

Defendant's Exhibit.

employs the organic acid from soaps. Now, it is old to employ such acids—see the "red oil" referred to in line 84, page 1 of 348,157, Everson, August 24, 1886, Washers, H, and it would not be a matter of invention to employ such oils obtained from soap, especially as Everson mixes her oils, including glycerides, (tallow, lard oil, etc.—which should release the acid on reaction with mineral acids)—with mineral acids, before separation. In view of this, the 1st claim is rejected as destitue of patentable novelty. See also 689,070, Elmore, Dec. 17, 1901, Washers, H.

The 3rd claim is rejected in view of the references for claim 1, and Lake, of record. Lake discloses the process excepting only as to the particular oil employed and Everson discloses the use of fatty acids. This claim should be made more specific.

The 2nd and 4th claims may possibly be allowed.

A. McNaught,

Act'n Examiner, Division XXV

T. F. Mitchell

Defendant's Exhibit.

Serial No. 200,649 Paper No. 4

Application Room
Dec 31 1904
U. S. Patent Office.
Room No. 315

Patent Office
Jan 3, 1905
Division XXV.

AMENDMENT.

Inventors: Cattermole, Sulman & Picard.
Invention: Ore Concentration.
Filed March 29, 1904. Serial No. 200649.

HON. COMMISSIONER OF PATENTS.

Sir:

The above-named application is hereby amended as follows:

Cancel claims 1 and 3 and insert:

B 1. The herein described process of concentrating ores which consists in mixing a freely flowing ore pulp with a soap solution and a mineral acid so as to liberate the organic acid from the soap throughout the suspended ore mass in intimate contact therewith, whereby the organic acid coats the desired mineral particles and not the gangue, and thereafter separating the coated mineral matter from the non-coated gangue.

B[1] 3. The herein described process of concentrating ores which consists in mixing a freely flowing ore pulp with a soap solution and a mineral acid so as to liberate the organic acid from the soap throughout the suspended ore mass in intimate contact therewith, bringing the liquor into intimate contact with a gas which will adhere to the coated particles and separating out the coated mineral matter which floats.

Defendant's Exhibit.

REMARKS.

The Examiner suggests that the only distinction of process in the first claim over Robson No. 575669 is in the particular re-agent and its method of formation; and again that Everson by suggesting the use of "red oil" has anticipated the Applicants. But it is to be noticed that these cited processes are really of entirely different type from that of the applicants.

Robson takes a plastic mass of ore, "avoiding as far as possible the presence of water"; he forces an oily liquid up through the mass and washes away the metallic matter in a stream of oil. Everson mixes the powdered ore with the oily substance so as to produce a stiff mass after the minerals have been incorporated, and thereafter the gangue is washed out of the pasty mass by water.. The real secret of successful separation is this, that each particle of mineral must be brought into intimate contact with the material used for separation. This cannot be done in a pasty mass. Applicants have discovered that when a soap solution is mixed with a freely flowing pulp and a mineral acid is added, the fatty acid is liberated throughout the suspended ore mass in the most intimate contact therewith, and thereby each mineral particle becomes coated or enclosed by a thin film of fatty or resin acid. Everson requires many times the quantity of oil that the applicants do, and the process as described by her is not commercially possible.

It is therefore respectfully submitted that Claim 1 in

its amended form clearly distinguishes the invention from the prior art.

With regard to claim 3 the applicants admit that Froment has discovered a process of gaseous flotation as applied to oil concentration and they have no desire to make a claim for such a process, but Froment was not aware of the advantages arising from the use of fatty or resin acids liberated from soaps and Froment could not have foreseen that the acid from a soap would form such a film on mineral particles that gaseous bubbles or the like would adhere to the particles and cause them to float. Moreover it is submitted that Claim 3, particularly in its amended form covers a novel combination of steps which constitutes a process which is accompanied by considerable utility.

Everson's U. S. Patent 348,157.

The powdered ore is mixed with an oily substance so as to produce a stiff mass after the materials have been incorporated and thereafter the gangue is washed out of the pasty mass by water. There is no suggestion here of the use of soap or the alternate formation of fatty acid and re-formation of soap.

Everson was ignorant of the chemical facts involved and states that in the case of petroleum or paraffine there is a compound produced between the mineral, water, acid and oil in the concentrates and infers a combination between dilute acid and paraffine. This is untrue; the action of concentration is purely a physical one.

A very important line of distinction between Ever-

Defendant's Exhibit.

son's process and the Applicants' is that Everson oils the whole of the *ore and gangue* initially as thoroughly as possible and seeks to wash the gangue out of the mass by acid water or the like. The Applicants on the other hand avoid any oiling of the gangue by wetting the whole first with water and by such preferential wetting and the mode of producing the oleic acid *only the metalliferous matter present is coated.* The Applicants never make a pasty mass of the whole ore but only seek to coat every particle of metalliferous matter as thinly and evenly as possible and therefore to keep the gangue and the mineral particles from agglomerating together.

It is absolutely essential to the success of the Applicants process that the fatty substance (oleic acid say) must be in the extremest sub-division and must make an intimate contact with the mineral, and the same uniform quantity with regard to any mineral particle, however small this ratio may be. This uniformity cannot be obtained by simply pouring oleic acid into the pulp. The only way of obtaining the small uniform layers of oleic acid on the individual particles is to add *a* soap solution which permeates the pulp completely, and then decomposing this in situ, i. e., in actual contact with the individual particles.

Respectfully submitted.

KNIGHT BROS

Attorneys.

WASHINGTON, D. C.,

December 31, 1904.

II.

Defendant's Exhibit.

A. R. 2-—181.

Issue Division Serial No. 200,649

All communications should be addressed to "The Commissioner of Patents, Washington, D. C."

DEPARTMENT OF THE INTERIOR,
U. S. PATENT OFFICE,
WASHINGTON, D. C., Feb. 6, 1905. 190....

ARTHUR E. CATTERMOLE, HENRY L. SULMAN and
HUGH F. KIRKPATRICK-PICARD,
% Knight Bros,
City

SIR:—Your APPLICATION for a patent for an IMPROVEMENT IN ORE CONCENTRATION. Filed March 29, 1904, 1...., has been examined and ALLOWED.

The final fee, TWENTY DOLLARS, must be paid, and the Letters Patent bear date as of a day not later than SIX MONTHS from the time of this present notice of allowance.

If the final fee is not paid within that period the patent will be withheld, and your only relief will be by a renewal of the application, with additional fees, under the provisions of Section 4897, Revised Statutes. The Office aims to deliver patents upon the day of their date, and on which their term begins to run; but to do this properly applicants will be expected to pay their final fees at least TWENTY DAYS prior to the conclusion of the six months allowed them by law. The printing, photolithographing, and engrossing of the several patent parts, preparatory to final signing and sealing, will

consume the intervening time, and such work will not be done until after payment of the necessary fees.

When you send the final fee you will also send, DISTINCTLY AND PLAINLY WRITTEN, the name of the INVENTOR and TITLE OF INVENTION AS ABOVE GIVEN, DATE OF ALLOWANCE (which is the date of this circular), DATE OF FILING, and, if assigned, the NAMES OF THE ASSIGNEES.

If you desire to have the patent issue to ASSIGNEES, an assignment containing a REQUEST to that effect, together with the FEE for recording the same, must be filed in this Office on or before the date of payment of final fee.

After issue of the patent uncertified copies of the drawings and specifications may be purchased at the price of 5 cents each. The money should accompany the order. Postage stamps will not be received.

Respectfully,

F. I. ALLEN.

Commissioner of Patents.

After allowance, and prior to payment of the final fee, applicants should carefully scrutinize the description to see that their statements and language are correct, as mistakes not incurred through the fault of the office, and not affording legal grounds for reissues, will not be corrected after the delivery of the letters patent to the patentee or his agent.

In remitting the final fee give the Serial Number at the head of this notice.

If payment is made by check or draft, the credit allowed is subject to the collection of the same.

Defendant's Exhibit.

2—327.

√$ 20.—Received
Apr 5 1905 Y
Chief Clerk. U. S. Patent Office

MEMORANDUM
of
FEE PAID AT UNITED STATES PATENT OFFICE.

(Be careful to give correct Serial No.)

Serial No. 200649 , 190....

Inventor:

Arthur E Cattermole, Henry L Sulman
& H F K Picard

Patent to be issued to

Name of invention, as allowed:

Ore Concentration

Date of Payment:

April 5 05

Fee:

$20

Date of Filing:

Mar 20-04

Date of Circular of Allowance:

Feb 6 05

The Commissioner of Patents will please apply the accompanying fee as indicated above.

Send Patent to KNIGHT BROS.
Knight Bros Attorney.
McGill bldg
City

Defendant's Exhibit.

C. E. R. 2—191.

Serial No. 200,649.

Address only "The Commissioner of Patents,
Washington, D. C."

DEPARTMENT OF THE INTERIOR

UNITED STATES PATENT OFFICE.

WASHINGTON, D. C., April 5, 1905.

ARTHUR E. CATTERMOLE, HENRY L. SULMAN
and HUGH F. KIRKPATRICK-PICARD,
C/o Knight Bros.,
City.

Sir:

You are informed that the final fee of TWENTY DOLLARS has been received in your application for Improvement in Ore Concentration.

Very respectfully

F. I. ALLEN.
Commissioner of Patents.

[Here follows printed copy of Patent 788,247.]

Defendant's Exhibit.

1904

CONTENTS:

83. Mills.
Ore and Coal
Washers.

Print

Application—papers. O. K.

1. Rej. Apr. 29, 1904.
2. Amendment A, Aug. 9, 1904.
3. Rej. Oct. 4, 1904.
4. Amend't B and Argt Dec. 21, 1904.
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TITLE:

Improvement in Ore Concentration

Defendant's Exhibit.

Defendant's Exhibit Certified Copy of File-Wrapper and Contents of Sulman, Kirkpatrick-Picard Patent No. 793,808.

UNITED STATES OF AMERICA,

DEPARTMENT OF THE INTERIOR,

UNITED STATES PATENT OFFICE.

To all to whom these presents shall come, Greeting:

This is to certify that the annexed is a true copy from the Records of this Office of the File Wrapper, Contents and Drawings, in the matter of the Letters Patent of Henry Livingstone Sulman, and Hugh Fitzalis Kirkpatrick-Picard, Number 793,808, Granted July 4, 1905, for Improvement in Ore Concentration.

In testimony whereof I have hereunto set my hand and caused the seal of the Patent Office to be affixed at the City of Washington, this 31st day of January, in the year of our Lord one thousand nine hundred and twelve and of the Independence of the United States of America the one hundred and thirty-sixth.

[SEAL.]

F. A. TENNANT

Assistant Commissioner of Patents.

Defendant's Exhibit.

2—437.

Number (Series of 1900). Div 25
175,871 (Ex'r's Book). 16-105
1903
Patent No. 793808

Name Henry Livingstone Sulman [1] and Hugh Fitzalis Kirkpatrick-Picard [2]
of London
County of
of England
Invention Ore Concentration

Division of App., No. , filed 190

Parts of Application filed.

	ORIGINAL.	RENEWED.
Petition	Oct 5, 1903	, 190
Affidavit	" ", 1903	, 190
Specification 3 shts	" ", 1903	, 190
Drawing Dec 15-	, 1903	, 190
Sub " 1 sht Mar 15	1905	, 190
Model or Specimen	Not req'd, 190	, 190
1 First Fee Cash $15.00	, 1903	, 190
" " Cert.	, 190	, 190
Appl. filed complete	Oct 5, 1903	, 190

Examined Lewis B. Wynne, Mch 27th 1905 , 190
Countersigned J W Babson , 190
For Commissioner. For Commissioner.
Notice of Allowance
March 29, 1905 , 190
Final Fee Cash $20. June 12, 1905 , 190
" " Cert. " , 190 , 190
2 Patented July 4 , 1905
Associate Attorney Attorney Knight Bros.
City.
McGill B'ld'g.
Name Serial Number
3 Patent No. Date of Patent

Defendant's Exhibit.

Joint. Serial No. 175,871 Paper No. ½
$15 Received Application 1903.
Oct 5 1903 H Filed
Chief Clerk. U. S. Patent Office

PETITION.

TO THE COMMISSIONER OF PATENTS.

Your Petitioners HENRY LIVINGSTONE SULMAN and HUGH FITZALIS KIRKPATRICK-PICARD, Subjects of the King of England and residents of London, England whose Post Office address is 44 London Wall, City of London, England and pray that Letters Patent may be granted to them, as joint inventors, for the Improvements in or relating to ore concentration, set forth in the annexed Specification, and they hereby appoint Knight Bros. Washington D. C. composed of Hervey S. and Harry A. Knight their Attorney with full power of substitution and revocation, to prosecute this application, to make alterations and amendments therein, to receive the Patent, and to transact all business in the Patent Office connected therewith.

Signed at London England this 25th day of September 1903.

HENRY LIVINGSTONE SULMAN
HUGH FITZALIS KIRKPATRICK-PICARD

U. S.

To all whom it may concern:—

Be it known that We, Henry Livingstone Sulman and Hugh Fitzalis Kirkpatrick-Picard, subjects of the King of England residing at London England have invented certain new and useful "Improvements in or Relating to Ore Concentration" of which the following is a specification:—

The present invention relates to the concentration of ores by separation of the metalliferous constituents and graphite, carbon, sulphur and the like from the gangue by means of oils, grease, tar, or any similar substance which has a preferential affinity for metalliferous matter over gangue.

According to this invention we utilize the power which is possessed by films or bubbles of air or other gas of attaching themselves to solid particles moistened by oil or the like.

According to one method of carrying out our invention suitably crushed ore is suspended in water; to this suspension a proportion of oil, grease or tar (hereinafter referred to as "oil") is added and duly mixed with the mass by any suitable means in quantity insufficient to raise the oiled mineral, by virtue of the flotation power of the oil alone.

A suitable gas is now generated in or introduced into the mixture, such as air, carbonic acid gas, sulphuretted hydrogen or the like. For example, bi-carbonates or carbonates, either soluble or insoluble in water (preferably the latter), or easily decomposible

Defendant's Exhibit.

sulphides and the like may be used with acid solution. In such cases, if desired, the addition of acid may be made to the mixture after the addition of the gas-producing reagent. In the case of solutions containing free alkali, the addition of acid sufficient to neutralize this must be made before the gas is produced. If desirable gaseous bubbles may be produced by electrolytic methods, or by means of various other known reactions.

According to another method of carrying out this invention, the "oil" is not added alone but the pulp is submitted to the action of a current of air or other gas-bubbles, the air or other gas being first suitably charged either with the vapour of a volatile oil, such as petroleum of low boiling point, or with the spray of any other suitable volatile or non-volatile or fixed oil or the like.

The oil may be sprayed or reduced to a state of

P. 1853, L. 21, "other gas current by the use of any suitable spraying or" insert before "atomizing"

preferably at the bottom, by means of a pipe or pipes provided with suitable perforations or by other suitable contrivance. The minute oil globules or the condensed vapours of volatile oils attach themselves to the metalliferous particles in preference to the gangue.

The oiled metalliferous particles resulting from either of the processes above described have the power of attaching to themselves with a greater comparative

Defendant's Exhibit.

U. S.

To all whom it may concern:—

Be it known that We, Henry Livingstone Sulman and Hugh Fitzalis Kirkpatrick-Picard, subjects of the King of England residing at London England have invented certain new and useful "Improvements in or Relating to Ore Concentration" of which the following is a specification:—

The present invention relates to the concentration of ores by separation of the metalliferous constituents and graphite, carbon, sulphur and the like from the gangue by means of oils, grease, tar, or any similar substance which has a preferential affinity for metalliferous matter over gangue.

According to this invention we utilize the power which is possessed by films or bubbles of air or other gas of attaching themselves to solid particles moistened

to this suspension a proportion of oil, grease or tar (hereinafter referred to as "oil") is added and duly mixed with the mass by any suitable means in quantity insufficient to raise the oiled mineral, by virtue of the flotation power of the oil alone.

A suitable gas is now generated in or introduced into the mixture, such as air, carbonic acid gas, sulphuretted hydrogen or the like. For example, bi-carbonates or carbonates, either soluble or insoluble in water (preferably the latter), or easily decomposible

sulphides and the like may be used with acid solution. In such cases, if desired, the addition of acid may be made to the mixture after the addition of the gas-producing reagent. In the case of solutions containing free alkali, the addition of acid sufficient to neutralize this must be made before the gas is produced. If desirable gaseous bubbles may be produced by electrolytic methods, or by means of various other known reactions.

According to another method of carrying out this invention, the "oil" is not added alone but the pulp is submitted to the action of a current of air or other gas-bubbles, the air or other gas being first suitably charged either with the vapour of a volatile oil, such as petroleum of low boiling point, or with the spray of any other suitable volatile or non-volatile or fixed oil or the like.

The oil may be sprayed or reduced to a state of such fine division that minute globules of the same can remain temporarily suspended in an air or atomizing device, and the air current introduced into the ore pulp, preferably at the bottom, by means of a pipe or pipes provided with suitable perforations or by other suitable contrivance. The minute oil globules or the condensed vapours of volatile oils attach themselves to the metalliferous particles in preference to the gangue.

The oiled metalliferous particles resulting from either of the processes above described have the power of attaching to themselves with a greater comparative

strength than the gangue particles, the films or bubbles of gas which exist in the mass, and are thus raised to the surface of the liquor by gaseous flotation; they can then be removed by skimming, or other suitable means. The gangue particles unwetted by oil or grease are not floated up with the oiled mineral particles, and thus in the main remain at the bottom of the vessel containing the mixture. The oil can then be removed from the oiled mineral by any suitable known means.

In the case in which oil spray is used, the temperature of the mass of pulp may be varied to secure the best results with spray of oils of varying viscosity. Instead of suspending the oil spray in an air supply system, suitably devised atomising jets operated by air, or a jet of steam and air may be introduced directly into the pulp. The gas used may be other than air such as carbonic acid, steam or mixtures of these.

We have also found that a particle of metalliferous mineral if coated with a minute film of oil, grease or the like then exposed to air will not readily sink in the water. It is therefore unnecessary in some instances to employ gaseous bubbles to effect flotation. For example according to an alternative method for effecting the separation of metalliferous matter from gangue, the metalliferous ore pulp is intimately mixed in any suitable manner with a small proportion of "oil" and then sprayed in as finely divided a state as necessary through air by means of jets, revolving discs or otherwise; and the sprayed product is then allowed

Defendant's Exhibit.

to fall upon the surface of water. The gangue particles wetted only with water at once sink, while the metalliferous particles coated with a thin film of oil and after exposure to air float on the surface of the water and may be removed by skimming or other suitable means. Before bringing the pulp into the necessary contact with air it will be obvious that the bulk of the water may first be removed by subsidence or other suitable means.

nrt B} c.15/03} This process has been described as applied to ore concentration by oil, but it is to be understood that it is equally applicable to concentration by the use of any other substance which has an affinity for metalliferous matter.

U. S.

---

b. B1 c 15/03 1. The hereindescribed process of concentrating ores which consists in bringing the pulp into intimate contact with "oil" and ~~was~~ with a gas and thereafter separating in water the metalliferous constituents from the gangue.

29/03

2. The hereindescribed process of concentrating ores which consists in bringing the pulp into intimate contact with a spray of "oil" and with a gas and thereafter separating in water the metalliferous constituents from the gangue.

29/03

3. The hereindescribed process of concentrating ores which consists in bringing the pulp into intimate contact with "oil," dissiminating the mixture through air and thereafter separating the metalliferous constituents from the gangue in water.

Iert A} c 29/03} IN TESTIMONY WHEREOF we have signed our names

Defendant's Exhibit.

to this Specification in the presence of two subscribing witnesses.

HENRY LIVINGSTONE SULMAN
HUGH FITZALIS KIRKPATRICK-PICARD

2 Witnesses

CLAUDE C R MCKENZIE

WALTER J. SKERTEN

OATH.

London }
England } ss

HENRY LIVINGSTONE SULMAN, and HUGH FITZALIS KIRKPATRICK-PICARD, the above named petitioners, being sworn, depose and say they are subjects of the King of England, and residents of London, in England, that they verily believe themselves to be the original, first and joint inventors of the "IMPROVEMENTS IN OR RELATING TO ORE CONCENTRATION" described and claimed in the annexed specification; ~~and~~ that they do not know and do not believe that the same was ever known or used before their invention or discovery thereof, or more than two years prior to this application, or in public use or on sale in the United States for more than two years prior to this application; that said invention has not been patented to them or to others with their knowledge or consent in this or any foreign country for more than two years prior to this application, or on an application for a patent filed in any country foreign to the United States by them or their legal representatives or assigns more than twelve months prior to their application; and that no appli-

Defendant's Exhibit.

cation for patent on said improvement has been filed by them or their representatives or assigns in any country foreign to the United States, except as follows: —in Great Britain under Nos: 16285, dated 23rd July 1903, and 20419 dated 22nd September 1903.

Inventors Signatures in full HENRY LIVINGSTONE SULMAN
HUGH FITZALIS KIRKPATRICK-PICARD

SWORN TO and subscribed before me this 25th day of September 1903. by both said Deponents

G. F. WARREN

(Notarial Seal.) Notary Public

[Revenue Stamp] M

CONSULATE-GENERAL OF THE UNITED STATES OF AMERICA FOR GREAT BRITAIN & IRELAND AT LONDON

I, Henry Clay Evans Consul-General of the United States of America at London, England do hereby make known and certify to all whom it may concern that George Frederick Warren who hath signed the annexed Certificate, is a Notary Public, duly admitted and sworn and practising in the city of London, aforesaid, and that to all acts by him so done full faith and credit are and ought to be given in Judicature and thereout.

In Testimony Whereof, I have hereunto set my hand and affixed my Seal of Office at London aforesaid, this 26″ day of September—in the year of our Lord One Thousand Nine Hundred and Three

H CLAY EVANS

(Consular Seal) Consul-General.

Defendant's Exhibit.

2—260

M. E. C.

Div. . . . . . . Room 315 Paper No. 1

Address only "The Commissioner of Patents, Washington, D. C."

All communications respecting this application should give the serial number, date of filing, and title of invention.

DEPARTMENT OF THE INTERIOR

UNITED STATES PATENT OFFICE

WASHINGTON, D. C., Oct. 20, 1903.

Mailed " " "

H. L. SULMAN & H. F. KIRKPATRICK-PICARD,
Care Knight Bros.,
City.

Please find below a communication from the EXAMINER in charge of your application. #175,871, filed Oct. 5, 1903, for Ore Concentration.

F. I. ALLEN,
Commissioner of Patents.

Applicants are required to supply a drawing illustrating means for carrying out the process described in this application.

The claims are rejected in view of British patent to Lake, 12778, of 1902, Washers; and e. g., 668,742, Redding, Feb. 26, 1901, Washers, A.

T. F. MITCHELL
Act'g Examiner,
Division XXV.

Defendant's Exhibit.

Application Room Oct 29 1903 U. S. Patent Office.

Serial No. 175,871 Paper No. 2

Patent Office Oct 31 1903 Division XXV.

Amendment.

Inventor: Sulman & Kirkpatrick-Picard.
Invention: Ore Concentration.
Filed October 5, 1903. Serial No. 175,871.

Hon. Commissioner of Patents.

Sir:—

The above-named application is hereby amended as follows:

Claims 1 and 2, line 4, after "separating" insert: *in water.*

Add the following claims:

A

celed
c. 5/03

4. A process for concentrating ores, which consists in suspending the crushed ore in water, blowing into the same a gas containing finely divided oil, and removing the floating metalliferous portion.

5. A process for concentrating ores consisting in suspending the crushed ore in water, discharging into the mixture a gas saturated with a volitalized oil, and removing the floating metallic portion.

6. A process for concentrating ores, which consists in blowing a hydrocarbon vapor into a mixture of crushed ore and water, and removing the floating particles.

Defendant's Exhibit.

7. A process for concentrating ores, which consists in treating the crushed ore with a hydrocarbon spray, separating in water the metallic portion from the gangue, and removing said metallic portion.

8. A process for concentrating ores which consists in mixing the crushed ore with a hydrocarbon, spraying the mixture into water, and removing the floating particles.

REMARKS.

Claims 1 and 2 have been amended to make clear the fact that the crushed ore is treated with the oil previously to being suspended in water. None of the references shows this feature. By treating the dry ore with oil the metallic particles are enabled to take up with the oil to a much greater extent than could occur in water consequently better results are obtained. Claims 3, 7 and 8 also make the same distinction.

Claims 4, 5 and 6 are drawn to include blowing a gas into the mixture of water and crushed ore. The only equivalent of this is found in the British patent cited, and as this reference calls for an acid solution and an effervescent salt to obtain the same result, the metal would be acted upon by the acid as long as it was in the liquid. The objections to this are obvious.

Claim 8 contains the additional feature of spraying the oiled, crushed ore upon water. This is broadly new we believe in so far as the reference discloses.

In the Redding reference no mention is made of using artificial means, such as oil, for floating the

Defendant's Exhibit.

metallic particles. We submit that this reference has no bearing on the claims.

In consideration of the amendment and remarks we respectfully urge a favorable action upon the claims, with the understanding that a drawing will be filed at an early date. Our client is abroad and there will necessarily be some lapse of time before we can receive a drawing from him in this case.

Respectfully submitted,

KNIGHT BROS

WASHINGTON, D. C.
October 28, 1903.
W.

2—260

M. E. C.

Div. . . . . . . Room 315 Paper No. 3

Address only "The Commissioner of Patents, Washington, D. C."

All communications respecting this application should give the serial number, date of filing, and title of invention.

DEPARTMENT OF THE INTERIOR

UNITED STATES PATENT OFFICE

WASHINGTON, D. C., November 12, 1903.
Mailed " " "

HENRY LIVINGSTONE SULMAN, and
HUGH FITZALIS KIRKPATRICK-PICARD,
Care Knight Bros.,
City.

Please find below a communication from the Ex-

AMINER in charge of your application. #175,871, filed Oct. 5, 1903, for Ore Concentration.

F. I. ALLEN,
Commissioner of Patents.

The amendment filed October 29, 1903, has been entered by inadvertence. Action on the merits must be refused until applicants restrict the claims to a simple species.

The spraying of the mixed pulp oil through air (claim 3); the *spraying* of pulp with oil before separation (claim 2); the *spraying* of crushed ore suspended in water (claim 4); the use of a gas carrying volatized oil (claim 5); are examples of different species, as are the methods of the 6th to 8th claims.

LEWIS B. WYNNE
Examiner,
Division XXV.

T F M

Defendant's Exhibit.

Serial No. 175,871 Paper No. 4

Application Room Patent Office
Dec 15 1903 Dec 16 1903
U. S. Patent Office. Division XXV.

Room No. 315.

AMENDMENT.

Inventors: Henry L. Sulman & H. F. Kirkpatrick-Picard.

Invention: Ore Concentration.

Filed October 5, 1903. Serial No. 175,871.

HON. COMMISSIONER OF PATENTS.

Sir:—

The above-named application is hereby amended as follows:

In accordance with the Examiner's requirements a drawing is filed herewith illustrating means for carrying out the process described in this application.

Specification: Page 4, line 14, after "means" insert:—

In the accompanying drawings:

Figure 1 is a diagram in longitudinal section of an apparatus suitable for carrying out this process.

Figure 2 is a diagram in perspective, partly in section of another form of suitable apparatus, and

Figure 3 is a diagram in perspective, partly in section of an alternative form of apparatus.

Defendant's Exhibit.

Referring to Figure 1, A is a tank for pulp which delivers through a pipe A′ to a concentrating tank B the bottom of which slopes downward from the inlet. The tank B is provided at the bottom with a coiled pipe B′ suitably perforated, supported in bearings B^2 and arranged to be rotated by means of a spur wheel B^3 or the like. Air is forced into this pipe B′ through a pipe C and oil is simultaneously introduced into the pipe C from a carburettor or the like C′. At the end of the tank B furtherest from the pulp inlet, a launder B^4 is placed to receive the discharge of floating material and an outlet tap B^5 is provided at the lowest point of the tank.

Referring to Figure 2, D is a tank in which pulp and oil are mixed and the mixture passes through an outlet tap D′ to an ejector E through which air under pressure is passed by the pipe E′. The spray of pulp, oil and air falls into a tank F filled with water and consisting of a series of communicating pointed boxes which increase in depth from the inlet end. A launder F′ is provided at the outlet end of the tank and outlet taps F^2 are placed at the lowest points of the boxes.

Referring to Figure 3, G is a tank in which pulp and oil are mixed, H is a circular disc attached to a vertical spindle H′ supported in bearings H^2 and arranged to be rotated through a driving pulley H^3 or the like. Surrounding the spindle is a cylindrical collar J connected with the tank G by a pipe J′ so that the pulp and oil are fed through the collar to the rotating disc. Surrounding the disc is a series of annular point-

ed troughs K communicating with one another and increasing in depth towards the outside and filled with water. A launder K′ is provided at the periphery of the outside trough to receive the discharged floating material and outlet taps K^2 are placed at the lowest points of the troughs.

Cancel the claims and substitute the following:

31 1. The herein described process of concentrating ores which consist in bringing the pulp into intimate contact with "oil" in the form of spray and with a gas and thereafter separating the metalliferous constituents from the gangue.

2. The herein described process of concentrating ores which consists in bringing the pulp into intimate contact with "oil" disseminating the mixture through air and thereafter separating the metalliferous constituents from the gangue water.

REMARKS.

The specifications cited have been considered and the Examiner's attention is directed to the following points:—

Lake (Froment) British Patent No. 12778/02. It is clear that this specification discloses the principle of the liberation of gas bubbles in a mixture of ore pulp and oil, in order to raise the oiled mineral to the surface; and Froment considers that the action takes place most effectively when the gas is in a nascent state

as when the gas is directly generated in the pulp. Froment, however, has not recognized the advantages which result from using oil in the form of spray.

It is very important to notice that if the oil be atomized in an air, or other gas current every minute particle of oil is brought into intimate contact with the gas and with the metalliferous mineral, with the result that the particles of oiled mineral adhere to films or bubbles of gas with great rapidity. Further, the particles of metalliferous mineral being in some cases very small, it is essential to have the oil and adhering gas in a correspondingly fine state of division and this is obtained in the Sulman and Picard process of atomizing the oil.

The particular method invented by Messrs. Sulman & Picard for causing the finely divided oil to be exposed to air is a specially rapid and convenient method of effecting the intimate contact of the minute particles of oil and mineral with air, and the resulting adhesion of these.

Redding U. S. No 668742. This specification describes an apparatus for separating graphite from ore, depending upon the fact that finely divided graphite will float on water. The ground ore is dropped on to a moving surface of water and is widely distributed and blown over the surface of the water. The heavy material sinks while the particles of graphite are floated off.

This is not an oil process: it is not suggested that

Defendant's Exhibit.

the air attaches itself in anyway to the graphite or that the flotation of the graphite is effected by the action of the air. On the contrary it is clearly stated on page 1 line 13 to 15 that the graphite floats because it is in the form of scales or laminæ which repel water.

So far as the Sulman & Picard process is concerned this citation appears to have no particular bearing, as owing to the absence of oil, it is impossible that Redding can have used a current of air for the purpose of producing intimate contact between the air and a spray of atomized oil to cause the latter to adhere to metalliferous mineral and float.

A favorable action is respectfully solicited.

Respectfully submitted,

KNIGHT BROS

Attorneys.

WASHINGTON, D. C.,

December 12, 1903.

W.

Defendant's Exhibit.

2—260

M. E. C. ———

Div. ...... Room 315 Paper No. 5

Address only "The Commissioner of Patents, Washington, D. C."

All communications respecting this application should give the serial number, date of filing, and title of invention.

DEPARTMENT OF THE INTERIOR

UNITED STATES PATENT OFFICE

WASHINGTON, D. C., Dec. 18, 1903.

Mailed " " "

SULMAN & KIRKPATRICK-PICARD,
Care Knight Bros.,
City.

Please find below a communication from the EXAMINER in charge of your application. #175,871, filed Oct. 5, 1903, for Ore Concentration.

F. I. ALLEN,
Commissioner of Patents.

Case as amended Dec. 15, 1903, further considered. The drawing filed has been criticized as follows: "Informal; space for heading required; see sheet 3. Admit for examination only." The claims bear the relation of two different species rather than that of genus and species. Restriction to a single species is required in advance of action upon the merits.

T. F. MITCHELL
Act'g Examiner,

T. F. Mitchell Div. XXVI

Defendant's Exhibit.

Application Room Serial No. 175.871 Paper No. 6
Mar 18 1904 Patent Office
U. S. Patent Office Mar 19 1904
Division XXV.
Room No. 315. Serial No. 175871.
Inventors: Sulman & Picard.
Invention: Ore Concentration.
Filed October 5, 1903.

HON. COMMISSIONER OF PATENTS.

Sir:

The Examiner's remarks have been considered and the inventors cannot appreciate the objection that "the claims bear the relation of two different species rather than of genus and species".

The essential feature of the applicants' invention is that in the separation of minerals by oil, the oil is used in the form of a spray and Messrs. Sulman & Picard have discovered that the affinity of the oil for the mineral and particles of air is more active and rapid if the oil be finely divided.

The first claim at present on file is as follows:—

The herein described process of concentrating ores which consists in bringing the pulp into intimate contact with oil in the form of spray and with a gas and thereafter separating the metalliferous constituents from the gangue.

It is submitted that this claim is directed to the genus of the process and while several methods have

been described and illustrated by which the oil may be sprayed, each of these methods comes within the scope of this first claim.

The second claim is specially directed to the preferred form of the process, as illustrated in Figure 3, consisting in bringing the pulp into intimate contact with the oil, disseminating the mixture through air and thereafter separating the metalliferous constituents from the gangue in water, but the oil at the moment when it becomes attached to the particles of air is clearly in the form of a spray and it is submitted that the process covered in claim 2 is therefore a species of that covered in claim 1 and a reexamination of the claims is therefore respectfully requested.

Respectfully submitted,

KNIGHT BROS.

Attorneys.

WASHINGTON, D. C.,

March 18, 1904.

H.

Defendant's Exhibit.

2—260

M. E. C.

Div. 25 Room 315 Paper No. 7

Address only "The Commisisoner of Patents, Washington, D. C."

All communications respecting this application should give the serial number, date of filing, and title of invention.

DEPARTMENT OF INTERIOR

UNITED STATES PATENT OFFICE

WASHINGTON, D. C. April 5, 1904.

Mailed " " "

HENRY LIVINGSTONE SULMAN & HUGH FITZALIS KIRKPATRICK-PICARD,

Care Knight Bros.,

City.

Please find below a communication from the EXAMINER in charge of your application #175,871, filed Oct. 5, 1903, for Ore Concentrator.

F. I. ALLEN,

Commissioner of Patents.

Case as argued March 18, 1904, further considered.

In view of the explanation supplied, the requirement of division is withdrawn.

The claims may possibly be allowed.

The case now awaits the relieving of the drawing of formal objections.

LEWIS B. WYNNE

Examiner,

T. F. Mitchell

Division XXV.

Defendant's Exhibit.

Application Room
Mar 15 1905
U. S. Patent Office.

Serial No. 175.871 Paper No. 8
Patent Office,
Mar 16 1905
Division XXV.

Room No. 315.

AMENDMENT.

Inventor: Henry L. Sulman & H. F. K. Picard.
Invention: Ore Concentration.
Filed October 5, 1903. Serial No. 175871.

HON. COMMISSIONER OF PATENTS.

Sir:

The above-named application is hereby amended as follows:

Cancel Figure 3 of the drawing now in the case and substitute the sheet of drawing attached hereto.

The case is now in condition for allowance and an early action is solicited.

Respectfully submitted,

KNIGHT BROS
Attorneys

WASHINGTON, D. C.,
March 14, 1905.

H.

Defendant's Exhibit.

A. R. 2—181.

Issue Division. Serial No. 175,871

All communications should be addressed to "The Commissioner of Patents, Washington, D. C."

DEPARTMENT OF THE INTERIOR,

U. S. PATENT OFFICE,

WASHINGTON, D. C., March 29, 1905, 190

HENRY L. SULMAN and
HUGH F. KIRKPATRICK-PICARD,
% Knight Bros,
City

Sir:—Your APPLICATION for a patent for an IMPROVEMENT IN Ore Concentration. Filed Oct. 5, 1903, 1 . . . . has been examined and ALLOWED.

The final fee, TWENTY DOLLARS, must be paid, and the Letters Patent bear date as of a day not later than SIX MONTHS from the time of this present notice of allowance.

If the final fee is not paid within that period the patent will be withheld, and your only relief will be by a renewal of the application, with additional fees, under the provisions of Section 4897, Revised Statutes. The Office aims to deliver patents upon the day of their date, and on which their term begins to run; but to do this properly applicants will be expected to pay their final fees at least TWENTY DAYS prior to the conclusion of the six months allowed them by law. The printing, photolithographing, and engrossing of the several patent parts, preparatory to final signing and sealing, will con-

sume the intervening time, and such work will not be done until after payment of the necessary fees.

When you send the final fee you will also send, DISTINCTLY AND PLAINLY WRITTEN, the name of the INVENTOR and TITLE OF INVENTION AS ABOVE GIVEN, DATE OF ALLOWANCE (which is the date of this circular), DATE OF FILING, and, if assigned, the NAMES OF THE ASSIGNEES.

If you desire to have the patent issue to ASSIGNEES, an assignment containing a REQUEST to that effect, together with the FEE for recording the same, must be filed in this Office on or before the date of payment of final fee.

After issue of the patent uncertified copies of the drawings and specifications may be purchased at the price of 5 cents each. The money should accompany the order. Postage stamps will not be received.

Respectfully,

F. I. ALLEN

Commissioner of Patents.

After allowance, and prior to payment of the final fee, applicants should carefully scrutinize the description to see that their statements and language are correct, as mistakes not incurred through the fault of the office, and not affording legal grounds for reissues, will not be corrected after the delivery of the letters patent to the patentee or his agent.

In remitting the final fee give the Serial Number at the head of this notice.

If payment is made by check or draft, the credit allowed is subject to the collection of the same.

Defendant's Exhibit.

2—327.

√ $20.00 Received
Jun 12 1905 H
Chief Clerk. U. S. Patent Office

MEMORANDUM
of
FEE PAID AT UNITED STATES PATENT OFFICE.

(Be careful to give correct Serial No.)

Serial No. 175871 , 190..

Inventor:
Henry L. Sulman & H F. Kirkpatrick Picard

Patent to be issued to

Name of invention, as allowed:
Ore Concentration

Date of Payment:
Jun 12-05

Fee:
$20

Date of Filing:
Oct 5- 1903

Date of Circular of Allowance:
March 29-05

The Commissioner of Patents will please apply the accompanying fee as indicated above.

Send Patent to KNIGHT BROS.
Knight Bros Attorney.
McGill Bldg
City

Defendant's Exhibit.

C. E. R. 2—191. Serial No. 175,871

Address only "The Commissioner of Patents, Washington, D. C."

DEPARTMENT OF THE INTERIOR

UNITED STATES PATENT OFFICE

WASHINGTON, D. C., June 12, 1905.

H. L. SULMAN & H. F. KIRKPATRICK-PICARD,
C/o Knight Bros.,
City.

Sir:

You are informed that the final fee of TWENTY DOLLARS has been received in your application for Improvement in Ore Concentration.

Very respectfully

F. I. ALLEN.
Commissioner of Patents.

[Here follows printed copy of Patent 793,808.]

Defendant's Exhibit.

1903

CONTENTS:

83. Mills
Ore and Coal
Washers.

Print

Application—papers. O. K.

1. Rej. Oct. 20, 1903
2. Amendment A. Oct. 29 1903
3. Rej Nov. 12 1903
4. Amendment B. Dec. 15, 1903.
5. Letter — Dec. 18, 1903
6. Argument Mar. 18, 1904.
7. Letter Apr. 5 1904
8. Amend't to Drg. Mar. 15, 1905
9.
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23.

TITLE:

Improvement in Ore Concentration

No. 793,808.

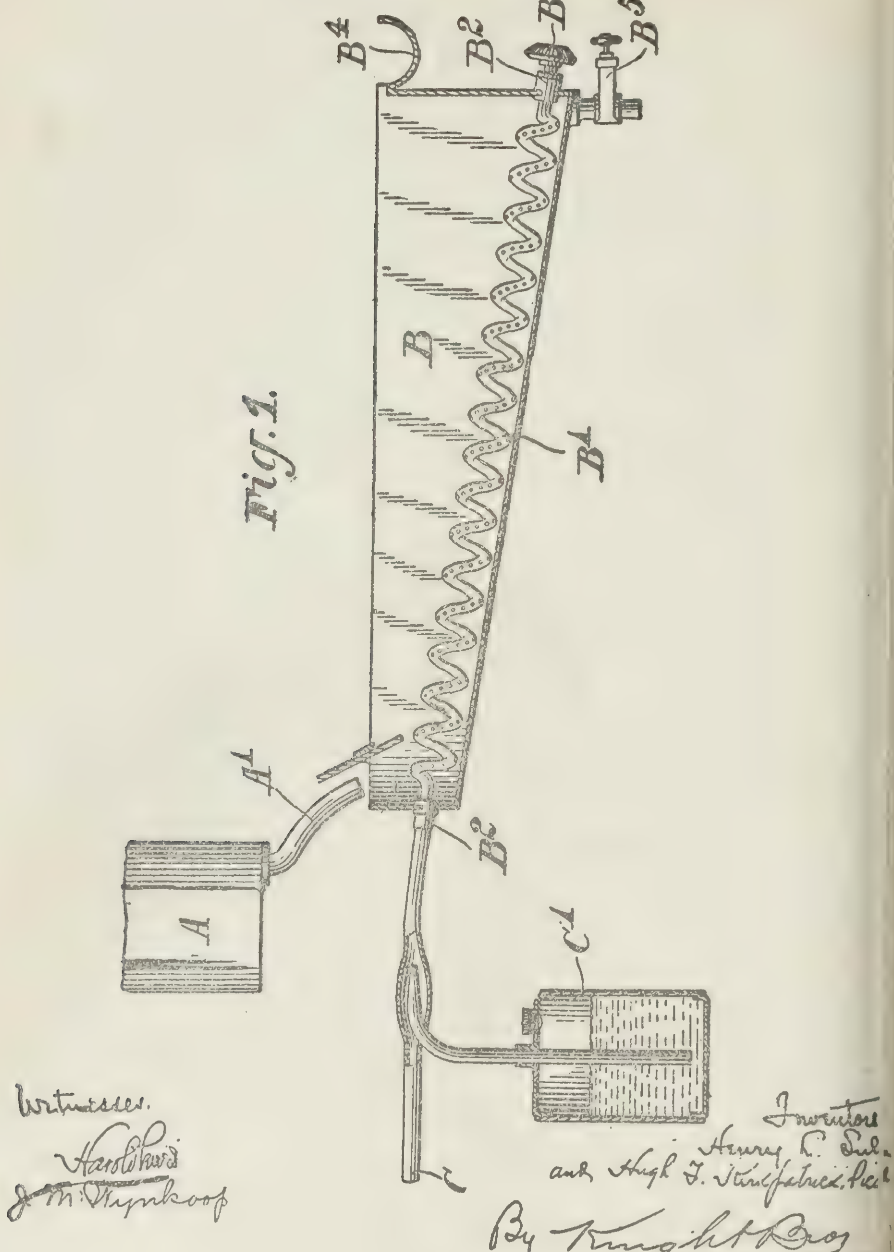
PATENTED JULY 4, 1905.

H. L. SULMAN & H. F. KIRKPATRICK-PICARD.

ORE CONCENTRATION.

APPLICATION FILED OCT. 5, 1903.

3 SHEETS—SHEET 1.



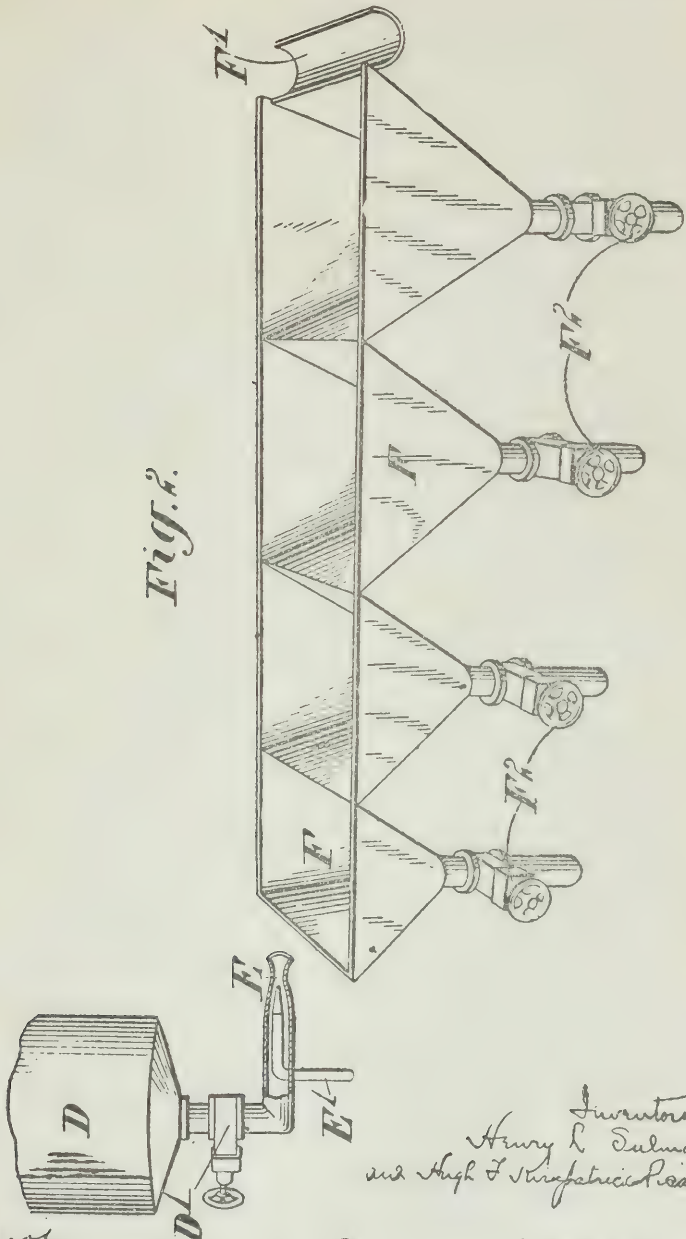
No. 793,808. PATENTED JULY 4, 1905.

H. L. SULMAN & H. F. KIRKPATRICK-PICARD.

ORE CONCENTRATION.

APPLICATION FILED OCT 5, 1903.

3 SHEETS—SHEET 2.



Witnesses
Harold Shaw
J. M. Stynkoof

Inventors
Henry L. Sulman
and Hugh F. Kirkpatrick-Picard

By Knight Bros.

No. 793,808.

PATENTED JULY 4, 1905.

H. L. SULMAN & H. F. KIRKPATRICK-PICARD.

ORE CONCENTRATION.

APPLICATION FILED OCT. 5, 1903.

3 SHEETS—SHEET 3.

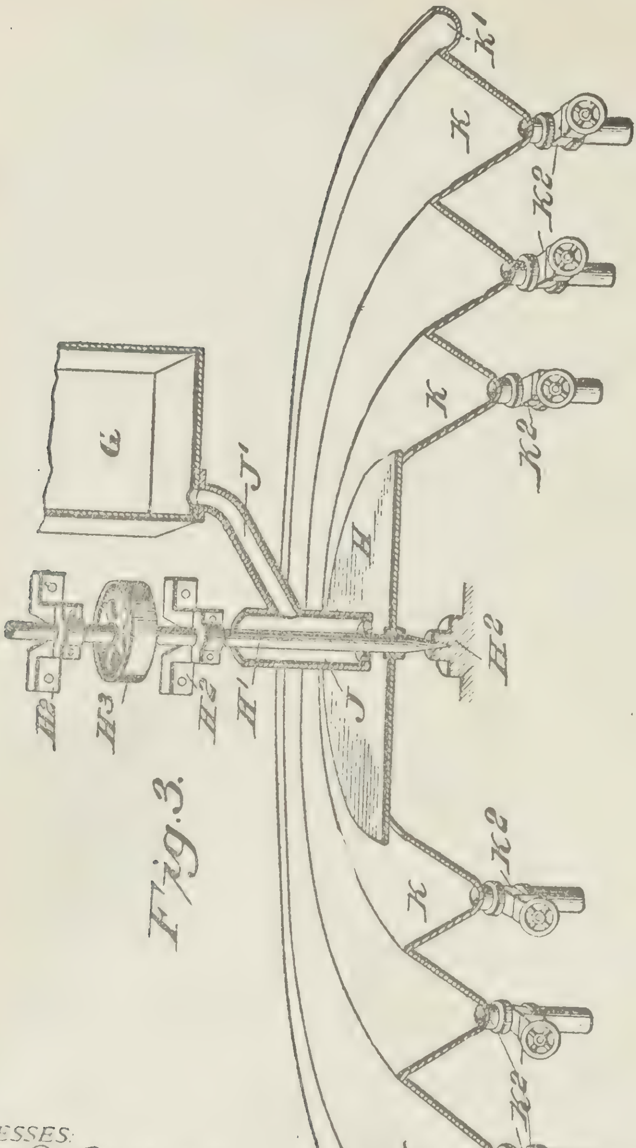


Fig. 3.

WITNESSES:
H. G. Dieterich
Jno. R. Adams

INVENTORS:
Henry L. Sulman
Hugh Fitzalis Kirkpatrick-Picard

BY Knight Bros

Attorneys

Defendant's Exhibit.

Defendant's Exhibit Certified Copy of File-Wrapper and Contents of Schwarz Patent No. 807,501.

UNITED STATES OF AMERICA,

DEPARTMENT OF THE INTERIOR,

UNITED STATES PATENT OFFICE.

To all to whom these presents shall come, Greeting:

This is to certify that the annexed is a true copy from the Records of this Office of the File Wrapper and Contents, in the matter of the Letters Patent of Alfred Schwarz, Assignor to Schwarz Ore Treating Company, Number 807,501, Granted December 19, 1905, for Improvement in Processes of Concentrating Ores.

In testimony whereof I have hereunto set my hand and caused the seal of the Patent Office to be affixed at the City of Washington, this 20th day of May, in the year of our [SEAL.] Lord one thousand nine hundred and twelve and of the Independence of the United States of America the one hundred and thirty-sixth.

F A TENNANT

Acting Commissioner of Patents.

Defendant's Exhibit.

2—437.

Div'n XXV

Number (Series of 1900).

1905 Div. 3 25

256,487 (Ex'r's Book). 62½

Patent No. 807,501 5

Name Alfred Schwarz

Assor to Schwarz Ore Treating Company, of Phoenix Territory of Arizona, a corporation of Territory of Arizona,

of New York

State of New York

Invention Process of Concentrating Ores

Division of App., No. , filed 190

Parts of application filed

	Original.		Renewed.
Petition	Apl. 19	, 1905	, 190
Affidavit	" "	, 1905	, 190
Specification	" "	, 1905	, 190
Drawing		, 190	, 190
Model or Specimen	Not req'd,	190	, 190
1 First Fee Cash $15	Apr. 9,	1905	, 190
" " Cert.		, 190	, 190
Appl. filed complete	Apl 19	, 1905	, 190

Examined Lewis B Wynne

July 12th 1905 , 190

Countersigned J W Babson , 190

For Commissioner. For Commissioner.

Notice of Allowance	July 13	, 1905	, 190
Final Fee Cash $20	Nov 25	, 1905	, 190
2 " " Cert.		, 190	, 190

Defendant's Exhibit.

Patented December 19, , 1905

Associate Attorney Attorney Chas. S. Jones

141-B'dway

New York, N. Y.

Name Serial Number

3 Patent No. Date of Patent

$15—Received

ck Apr 19 1905 Y

Chief Clerk U. S. Patent Office

NEW YORK, April 15, 1905.

HON. COMMISSIONER OF PATENTS,
Washington, D. C.

Sir:—

I enclose herewith the papers in the matter of the application of Alfred Schwarz for an improvement in the Process of Concentrating Ores together with check for $15.00 in payment of the filing fee thereon.

Respectfully,

CHARLES S JONES

(Enclo.)

Defendant's Exhibit.

√

Mail Room Application
Apr 19 1905 Serial No. 256,487 Paper No. ½
U. S. Patent Office.

PETITION.

TO THE COMMISSIONER OF PATENT.:—

Your petitioner, ALFRED SCHWARZ, a subject of the Emperor of Germany and a resident of the Borough of Manhattan, City, County and State of New York, and whose Post Office address is No. 505 Broome Street, in the said City and State of New York, prays that Letters Patent may be granted to him for the new and useful improvements in the PROCESS OF CONCENTRATING ORES set forth in the annexed specification; and he hereby appoints Charles S. Jones of 141 Broadway in the said City, County and State of New York, his attorney with full power of substitution and revocation, to prosecute this application, to make alterations and amendments therein, to sign the drawings, to receive the patent and to transact all business in the Patent Office connected therewith.

Signed at New York City, this 31st day of January 1905

ALFRED SCHWARZ

TO ALL WHOM IT MAY CONCERN, be it known that I, ALFRED SCHWARZ, a subject of the Emperor of Germany and a resident of the Borough of Manhattan, City,

Defendant's Exhibit.

County and State of New York, have invented certain new and useful improvements in the PROCESS OF CONCENTRATING ORES of which the following is a specification.

In the concentration of ores by the employment of hydrocarbons as adhesive agents, it has been observed that sulfids yield better results than oxids, carbonates and chlorids. In fact, so far as known to me, a practical application of such process before my inventions relating to this art, has been largely, if not wholly, confined to sulfid ores. The object of the present invention is to extend the application of hydrocarbon concentrating processes to ores heretofore considered unworkable, by first converting such ores into sulfids preferably by a wet method to thereby preserve the mass of ore in its crushed condition and suitable for treatments according to known methods.

In carrying out the present invention I proceed by preparing a soluble sulfid in any well known manner, for example by dissolving sulfur in an aqueous solution of potassium or sodium hydrate, the sulfur being added in sufficient quantity to give the desired reaction. The pulverized ore containing the mineral in the form of oxid, carbonate or chlorid is then mixed in a suitable vessel with the sulfid solution, the mass being either cold or heated by suitable means and the vessel provided with an agitator to effect a thorough and intimate mixture. During this operation the oxid, carbonate or chlorid is converted into a sulfid by the action of the potassium or sodium sulfid, a form which

is capable of subsequent practical treatment with hydrocarbons for the separation of the values from the earthy or rocky constituents of the ore. As the action of the hydrocarbon on the metallic constituents of the ore is a surface action, it is unnecessary to proceed so far as to convert the entire mass of the particles of oxid, carbonate or chlorid into a sulfid, it being sufficient if the surface of the particles is so converted as thereby there is presented all that is necessary for the desired action of the hydrocarbon.

After the initial conversion as above described the ore may be concentrated by any suitable treatment with a hydrocarbon, and for such purpose I may use a hydrocarbon which is normally liquid, or one which is solid at normal temperatures, or the latter in admixture with the former as described in my application serial Nos. 210,137, 210,138, 225,370 and 231,395 and U. S. Patent No. 771, 277. Of hydrocarbons which are solid at normal temperatures and required to be melted there may be used paraffin or ozocerite, or a resinous hydrocarbon such as resin, pitch or asphaltum. Of normal liquid hydrocarbons there may be used any suitable vegetable, animal or mineral oil. These hydrocarbons may be used singly or in combination of two or more, it being understood that the constitution of the adhesive agent will depend upon the character of the ore to be treated, varying as the ore varies.

Ore, either in a dry or wet condition, is mixed in any suitable vessel having an agitator with the hydrocarbon, sufficient quantity being added to effect the

desired separation. If the hydrocarbon is one which is solid at normal temperatures, it is first melted and then stirred in with the ore, the mixture being effected by any suitable mechanical means and if desired air, steam or gas may be injected into the mass either alone or to assist the mechanical agitation. The injection of such gaseous agent results in the hydrocarbon taking up an appreciable quantity of air or gas giving a certain sponginess which increases its floating power.

As a specific example of my invention I have used as an adhesive agent a mixture of paraffin and resin, heat being employed if necessary to maintain this compound in a melted condition after it has been mixed with the ore.

After an intimate mixture with all parts of the ore has been effected the mass is subjected to the action of water heated to any desired temperature even as high as the boiling point whereby the earthy or rocky constituents are liberated and washed out and settled in the bottom of the vessel. The metallic constituents of the ore having united with the adhesive agent may be skimmed or screened off and run to a centrifugal drier for the separation or recovery of the concentrates from the adhesive agent.

Instead of subjecting the mass to the action of heated or boiling water, cold water, preferably under pressure, may be injected into the mass, the effect of which is to solidify or granulate the adhesive agent, which, with the entrapped metallic constituents, may

Defendant's Exhibit.

be floated or screened off, while the tailings being saturated with water will be precipitated more or less completely to the bottom of the vessel. By subjecting the mass to heat in a suitable vessel the adhesive agent is melted and the concentrates may be separated and rcovered therefrom by a centrifugal drier, filter press or other means. The mass of ore and adhesive agent may first be treated with heated or boiling water and subsequently treated with cold water. Also during the treament with water which may be made acid or alkaline if desired, the mass may be agitated mechanically or by the injection of air, steam or gas.

The concentrates if necessary may be washed with a solution of potassium or sodium hydrate to remove any remaining portions of the adhesive agent.

While I have described in giving a specific method of procedure the use of a mixture of paraffin and resin, I may use either one of these singly, the successive steps of the operation being the same. Or I may use singly or normally liquid hydrocarbon following the same method of operation except in such case there will of course be no solidification or granulation of the hydrocarbon. When using a normally liquid hydrocarbon the mass may be treated either with cold or heated water to effect the separation of the adhesive agent with the metallic constituents of the ore from the tailings.

The essential feature of the present invention is the conversion of an ore of the character above specified into a sulfid to adapt it for treatment by a

hydrocarbon. The particular method of concentrating by the employment of a hydrocarbon being varied according to known methods as may be desired or suitable to the particular ore, and while I have given specific examples, I do not wish to be wholly restricted thereto.

In carrying out the conversion above described, I use an excess of sulfur above the theoretical quantity necessary to effect the change of oxid, carbonate or chlorid to sulfid.

What I claim and desire to secure by Letters Patent is:—

1. The method of treating ores which consists in subjecting a non-sulfid ore to the action of a soluble sulfid to convert the mineral into a sulfid, then treating the mass with a hydrocarbon and finally separating the hydrocarbon with the entrapped metallic constituents of the ore from the tailings.

non-sulfid mineral

2. The method of treating an ore containing ~~the mineral in the form of an oxid, carbonate or chlorid~~ by subjecting the same to the action of an alkaline sulfid to convert the mineral into a sulfid, then treating the mass with a hydrocarbon and finally separating the hydrocarbon with the entrapped metallic constituents of the ore from the tailings.

non-sulfid mineral

3. The method of treating an ore containing ~~the mineral in the form of an oxid, carbonate or chlorid~~ by subjecting the same to the action of an aqueous solution of potassium or sodium sulfid to convert the mineral into a sulfid, then treating the mass with hydro-

Defendant's Exhibit.

carbon and finally separating said hydrocarbon with the entrapped metallic constituents of the ore from the tailings.

June 30/05 4. The method of treating an ore containing non-sulfid mineral ~~the mineral in the form of an oxid, carbonate or chlorid~~ by subjecting the same to the action of a soluble sulfid with a melted hydrocarbon which is solid at normal temperatures and finally separating said hydrocarbon with the entrapped metallic constituents from tailings.

June 30/05 5. The method of treating an ore containing non-sulfid mineral ~~the mineral in the form of an oxid, carbonate or chlorid~~ by subjecting the resulting metallic sulfid with a compound of melted paraffin and resin, then separating said compound with entrapped metallic constituents from the tailings.

In testimony whereof I have hereunto signed my name in the presence of two subscribing witnesses:

Alfred Schwarz

Witnesses:

E. F. Porter

Alexander Rodman

State of New York }
County of New York } ss:

Alfred Schwarz, the above-named petitioner, being See Oath filed June 30/05 duly sworn deposes and says that he is a subject of the Emperor of Germany and a resident of the Borough of Manhattan, City, County and State of New York; that he verily believes himself to be the original, first and

Defendant's Exhibit.

sole inventor of the improvements in the PROCESS OF CONCENTRATING ORES described and claimed in the annexed specification; that he does not know and does not believe that the same was ever known or used before his invention or discovery thereof, or patented or

to this application; that said invention has not been patented to him or to others with his knowledge or consent in this or any foreign country for more than

on an applica-

tion, and that no application for a patent on said improvement has been filed by him or his legal representatives or assigns in any country foreign to the United States.

ALFRED SCHWARZ

SWORN TO AND SUBSCRIBED before me this 31st day of January 1905.

E. F. PORTER
Notary Public, No. 58 Kings Co.
[SEAL.] Certificate filed in N. Y. Co.

Defendant's Exhibit.

carbon and finally separating said hydrocarbon with the entrapped metallic constituents of the ore from the tailings.

non-sulfid mineral

4. The method of treating an ore containing ~~the~~

June 30/05 ~~mineral in the form of an oxid~~, ~~carbonate or chlorid~~

P. 1890, L. 8, insert " then treating the resulting metallic sulfid " before " with a "

tailings.

non-sulfid mineral

5. The method of treating an ore containing ~~the~~

June 30/05 ~~mineral in the form of an oxid carbonat~~

P. 1890, L. 14, insert " same to the action of a soluble sulfid then treating the " before " resulting "

from the tailings.

In testimony whereof I have hereunto signed my name in the presence of two subscribing witnesses:

Alfred Schwarz

Witnesses:

E. F. Porter

Alexander Rodman

State of New York }
County of New York } ss:

Alfred Schwarz, the above-named petitioner, being

See Oath filed June 30/05 duly sworn deposes and says that he is a subject of the Emperor of Germany and a resident of the Borough of Manhattan, City, County and State of New York; that he verily believes himself to be the original, first and

sole inventor of the improvements in the PROCESS OF CONCENTRATING ORES described and claimed in the annexed specification; that he does not know and does not believe that the same was ever known or used before his invention or discovery thereof, or patented or described in any printed publication in any country before his invention or discovery thereof, or more than two years prior to this application, or in public use or on sale in the United States for more than two years prior to this application; that said invention has not been patented to him or to others with his knowledge or consent in this or any foreign country for more than two years prior to this application; or on an application for a patent filed in any country foreign to the United States by him or his legal representatives or assigns more than twelve months prior to this publication, and that no application for a patent on said improvement has been filed by him or his legal representatives or assigns in any country foreign to the United States.

ALFRED SCHWARZ

SWORN TO AND SUBSCRIBED before me this 31st day of January 1905.

E. F. PORTER

Notary Public, No. 58 Kings Co.

[SEAL.] Certificate filed in N. Y. Co.

Defendant's Exhibit.

2—260

Div. 25 Room 315 Paper No. 1

Address only "The Commissioner of Patents, Washington, D. C."

All communications respecting this application should give the serial number, date of filing, and title of invention.

DEPARTMENT OF THE INTERIOR

UNITED STATES PATENT OFFICE

WASHINGTON, D. C., June 20, 1905.
Mailed " " "

ALFRED SCHWARZ,
Care Chas. S. Jones,
New York City.

Please find below a communication from the EXAMINER in charge of your application. #256,487, filed April 19, 1905, for Process of Concentrating Ores.

F. J. ALLEN
Commissioner of Patents.

The 2nd, 3rd, 4th and 5th claims are alternative in form in reciting "an oxid, carbonate or chlorid". It is suggested that a single non-alternative generic expression be employed in lieu of the alternative one quoted; thus the material might be defined as "ore containing non-sulfid mineral". With the change suggested, the claims would probably be allowable.

Defendant's Exhibit.

In view of the delay between the execution of the oath and the filing of the application, a new oath is required *ex parte* Branna, 97 O. G., 2533.

LEWIS B. WYNNE
Examiner,
Division XXV.

T. F. MITCHELL

Mail Room
Jun 30 1905
U. S. Patent Office.
Room 315.

Patent Office
Jun 30 1905
Division XXV.

Serial No. 256.487 Paper No. 2

Application of Alfred Schwarz.
Serial No. 256,487.
Filed April 19, 1905.
Process of Concentrating Ores.

HON. COMMISSIONER OF PATENTS.
Washington, D. C.
Sir:—

Replying to the Examiner's letter of June 20th, 1905, please amend the above entitled application as follows:—

Claim 2, line 2, cancel "the mineral in the form of an oxid, carbonate or chlorid" and substitute therefor "non-sulfid mineral."

Claim 3, lines 1 & 2 2, cancel "the "mineral in the form of an oxid, carbonate or chlorid" and substitute therefor "non-sulfid mineral."

Defendant's Exhibit.

Claim 4, line 2, cancel "the mineral in the form of an oxid, carbonate or chlorid" and substitute therefor "non-sulfid mineral."

Claim 5, line 2, cancel "the mineral in the form of an oxid, carbonate or chloride" and substitute therefor "non-sulfid mineral."

The claims have been amended in accordance with the Examiner's suggestion.

A new oath is enclosed herewith.

An early allowance of the case is requested.

Respectfully submitted,

CHARLES S JONES

Attorney for Applicant.

Dated New York City, N. Y., June 22, 1905.

In the matter of the application of Alfred Schwarz, Serial No. 256,487 filed April 19, 1905, Process of Concentrating Ores.

STATE OF NEW YORK }
COUNTY OF NEW YORK } ss:—

ALFRED SCHWARZ, the petitioner named in the above entitled application, being duly sworn deposes and says that he is a subject of the Emperor of Germany and a resident of the Borough of Manhattan, City, County and State of New York; that he verily believes himself to be the original, first and sole inventor of the improvements in the PROCESS OF CONCENTRATING ORES described and claimed in the specification annexed to said petition; that he does not know and does not believe that the same was ever known or used before

Defendant's Exhibit.

his invention or discovery thereof, or patented or described in any printed publication in any country before his invention or discovery thereof, or more than two years prior to the filing of said application, or in public use or on sale in the United States for more than two years prior to the filing of said application; that said invention has not been patented to him or to

P. 1895, L. 11, insert " or on an application for a patent filed in any country foreign to the United States by him or his legal representatives or assigns more than twelve months prior to the filing of said application " before " and that "

ALFRED SCHWARZ

Subscribed and sworn to before me this 28th day of June 1905.

OLIN A FOSTER

Notary Public, Queens County

[SEAL.] Certificate filed in New York County

Defendant's Exhibit.

Claim 4, line 2, cancel "the mineral in the form of an oxid, carbonate or chlorid" and substitute therefor "non-sulfid mineral."

Claim 5, line 2, cancel "the mineral in the form of an oxid, carbonate or chloride" and substitute therefor "non-sulfid mineral."

The claims have been amended in accordance with

Dated New York City, N. Y., June 22, 1905.

In the matter of the application of Alfred Schwarz, Serial No. 256,487 filed April 19, 1905, Process of Concentrating Ores.

STATE OF NEW YORK }
COUNTY OF NEW YORK } ss:—

ALFRED SCHWARZ, the petitioner named in the above entitled application, being duly sworn deposes and says that he is a subject of the Emperor of Germany and a resident of the Borough of Manhattan, City, County and State of New York; that he verily believes himself to be the original, first and sole inventor of the improvements in the PROCESS OF CONCENTRATING ORES described and claimed in the specification annexed to said petition; that he does not know and does not believe that the same was ever known or used before

Defendant's Exhibit.

his invention or discovery thereof, or patented or described in any printed publication in any country before his invention or discovery thereof, or more than two years prior to the filing of said application, or in public use or on sale in the United States for more than two years prior to the filing of said application; that said invention has not been patented to him or to others with his knowledge or consent in this or any foreign country for more than two years prior to the filing of said application, and that no application for a patent on said improvement has been filed by him or his legal representatives or assigns in any country foreign to the United States.

ALFRED SCHWARZ

Subscribed and sworn to before me this 28th day of June 1905.

OLIN A FOSTER
Notary Public, Queens County
[SEAL.] Certificate filed in New York County

Defendant's Exhibit.

ASW 2—181 Serial No. 256,487

Issue Division.

All communications should be addressed to "The Commissioner of Patents, Washington, D. C."

DEPARTMENT OF THE INTERIOR,

UNITED STATES PATENT OFFICE,

WASHINGTON, D. C., July 13, 1905

ALFRED SCHWARZ, Assor
C/o Chas. S. Jones
141 Broadway
New York, N. Y.

Sir: Your APPLICATION for a patent for an IMPROVEMENT IN PROCESS OF CONCENTRATING ORES filed Apl 19, 1905, has been examined and ALLOWED.

The final fee, TWENTY DOLLARS, must be paid, and the Letters Patent bear date as of a day not later than SIX MONTHS from the time of this present notice of allowance.

If the final fee is not paid within that period the patent will be withheld, and your only relief will be by a renewal of the application, with additional fees, under the provisions of Section 4897, Revised Statutes. The office aims to deliver patents upon the day of their date, and on which their term begins to run; but to do this properly applicants will be expected to pay their final fees at least TWENTY DAYS prior to the conclusion

Defendant's Exhibit.

of the six months allowed them by law. The printing, photolithographing, and engrossing of the several patent parts, preparatory to final signing and sealing, will consume the intervening time, and such work will not be done until after payment of the necessary fees.

When you send the final fee you will also send, DISTINCTLY AND PLAINLY WRITTEN, the name of the INVENTOR and TITLE OF INVENTION AS ABOVE GIVEN, DATE OF ALLOWANCE (which is the date of this circular), DATE OF FILING, and, if assigned, the NAMES OF THE ASSIGNEES.

If you desire to have the patent issue to ASSIGNEES, an assignment containing a REQUEST to that effect, together with the FEE for recording the same, must be filed in this office on or before the date of payment of final fee.

After issue of the patent uncertified copies of the drawings and specifications may be purchased at the price of FIVE CENTS EACH. The money should accompany the order. Postage stamps will not be received.

Respectfully,

F. J. ALLEN

Commissioner of Patents.

After allowance, and prior to payment of the final fee, applicants should carefully scrutinize the description to see that their statements and language are correct, as mistakes not incurred through the fault of the office, and not affording legal grounds for reissues, will not be corrected after the delivery of the letters patent to the patentee or his agent.

Defendant's Exhibit.

In remitting the final fee give the serial number at the head of this notice.

If payment is made by check or draft, the credit allowed is subject to the collection of the same.

2—103.

$20 received as the final fee in the application of A Schwarz 256487 for Process of Concentrating Ores applied from a composite letter No. 219761 received Nov 25 1905 from Jones C S which is on file in the Chief Clerk's room. B/M R

J W BABSON
Chief of Issue and Gazette Division.

J J D

Defendant's Exhibit.

SM

Issue Division 2—191. Serial No. 256,487

Address only "The Commissioner of Patents, Washington, D. C."

DEPARTMENT OF THE INTERIOR,

UNITED STATES PATENT OFFICE

WASHINGTON, D. C., Nov. 25, 1905.

ALFRED SCHWARZ, Assor.,
C/o Chas. S. Jones,
141 Broadway,
New York, N. Y.

Sir:

You are informed that the final fee of TWENTY DOLLARS has been received in your application for Improvement in Process of Concentrating Ores.

Very respectfully

F. I. ALLEN

Commissioner of Patents.

[Here follows printed copy of Patent 807,501.]

Defendant's Exhibit.

83. MILLS.
Ore and Coal
Washers.

1905

CONTENTS:

Print

Application—— Papers

1. Letter June 20, 1905
2. Amendment June 30, 1905.
3.
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8.
9.
10.
11.
12.
13.
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21.
22.
23.

TITLE:

Improvement in Process of Concentrating Ores.

Defendant's Exhibit.

Defendant's Exhibit Certified Copy of File-Wrapper and Contents of Schwarz Patent No. 807,503.

UNITED STATES OF AMERICA,

DEPARTMENT OF THE INTERIOR,

UNITED STATES PATENT OFFICE.

To all to whom these presents shall come, Greeting:

THIS IS TO CERTIFY that the annexed is a true copy from the Records of this Office of the File Wrapper and Contents, in the matter of the Letters Patent of Alfred Schwarz, Assignor to The Schwarz Ore Treating Company, Number 807,503, Granted December 19, 1905, for Improvement in Processes of Concentrating Ores.

IN TESTIMONY WHEREOF I have hereunto set my hand and caused the seal of the Patent Office to be affixed at the City of Washington, this 20th day of May, in the year [SEAL.] of our Lord one thousand nine hundred and twelve and of the Independence of the United States of America the one hundred and thirty-sixth.

F A TENNANT

Acting Commissioner of Patents.

Defendant's Exhibit.

2—437.

Number (Series of 1900). Div'n. XXV.
210138 1904 Div 25
Patent No. 807,503 (Ex'r's Book). 86-145
Name Alfred Schwarz,
Assor to The Schwarz Ore Treating Company, of Phoenix, Ter. of Arizona, a corp of Ter of Arizona
of New York (Manhattan)
County of
State of New York
Invention Process of Concentrating Ores.

Division of App., No. , filed , 190

Parts of application filed

	ORIGINAL.	RENEWED.
Petition	May 27, 1904	, 190
Affidavit	" ", 1904	, 190
Specification	" ", 1904	, 190
Drawing	May 10, 1905	, 190
Model or Specimen not reqd	, 190	, 190
First Fee Cash $15,	May 27, 1904	, 190
1 " " Cert.	, 190	, 190
Appl. filed complete	May 27, 1904	, 190
Examined Lewis B. Wynne Ex	June 29th, 1905	, 190
Countersigned J. W. Babson		, 190
	For Commissioner.	For Commissioner.
Notice of Allowance	July 6, 1905	, 190
Final Fee Cash $20.	Nov. 25, 1905	, 190
2 " " Cert.	, 190	, 1905

Defendant's Exhibit.

Associate Attorney — Attorney Chas. S. Jones,
141 Broadway,
New York, N. Y.

Name — Serial Number
3 Pat No. — Date of Patent

2–057.

15^{00} received as the application fee in the application of A. Schwarz for Process of Concentrating Ores applied from a composite letter No. 101469 received May 27/04 from Chas. S. Jones which is on file in the Chief Clerk's room.

App/D.
S. M. Pol
Application Clerk.

S. H. S.

Mail Room — Serial No. 210,138 — Paper No. ½
May 27 1904
U. S. Patent Office — Application.

PETITION.

TO THE COMMISSIONER OF PATENTS:—

Your petitioner, ALFRED SCHWARZ, a subject of the Emperor of Germany and a resident of the Borough of Manhattan, City, County and State of New York, and whose Postoffice address is No. 44 Broad Street, in the said City and State of New York, prays that Letters Patent may be granted to him for the new and useful improvements in the PROCESS OF CONCEN-

Defendant's Exhibit.

2—437.

Number (Series of 1900). Div'n. XXV.
210138 1904 Div 25
Patent No. 807,503 (Ex'r's Book). 86-145
Name Alfred Schwarz,

Assor to The Schwarz Ore Treating Company, of Phoenix, Ter. of Arizona, a corp of Ter of Arizona
of New York (Manhattan)
County of
State of New York
Invention Process of Concentrating Ores.

Division of App., No. , filed , 190

Parts of application filed

	Original.	Renewed.
Petition	May 27, 1904	, 190
Affidavit	" ", 1904	, 190
Specification	" ", 1904	, 190
Drawing	May 10, 1905	, 190
Model or Specimen not reqd	, 190	, 190
First Fee Cash $15,	May 27, 1904	, 190
1 " " Cert.	, 190	, 190
Appl. filed complete	May 27, 1904	, 190
Examined Lewis B. Wynne Ex		
	June 29th, 1905	, 190
Countersigned J. W. Babson		, 190
	For Commissioner.	For Commissioner.
Notice of Allowance	July 6, 1905	, 190
Final Fee Cash $20.	Nov. 25, 1905	, 190
2 " " Cert.	, 190	, 1905

P. 1902, after last line insert "Patented December 19, 1905"

Defendant's Exhibit.

Associate Attorney Attorney Chas. S. Jones,
141 Broadway,
New York, N. Y.

Name Serial Number
3 Pat No. Date of Patent

2–057.

$15[00] received as the application fee in the application of A. Schwarz for Process of Concentrating Ores applied from a composite letter No. 101469 received May 27/04 from Chas. S. Jones which is on file in the Chief Clerk's room.

App/D.
S. M. Pol
S. H. S. Application Clerk.

Mail Room Serial No. 210,138 Paper No. ½
May 27 1904
U. S. Patent Office Application.

Petition.

To the Commissioner of Patents:—

Your petitioner, Alfred Schwarz, a subject of the Emperor of Germany and a resident of the Borough of Manhattan, City, County and State of New York, and whose Postoffice address is No. 44 Broad Street, in the said City and State of New York, prays that Letters Patent may be granted to him for the new and useful improvements in the Process of Concentrating Ores set forth in the annexed specification;

Defendant's Exhibit.

and he hereby appoints Charles S. Jones of 141 Broadway in the said City, County and State of New York, his attorney, with full power of substitution and revocation, to prosecute this application, to make alterations and amendments therein, to sign the drawings, to receive the patent and to transact all business in the Patent Office connected therewith.

Signed at New York City, this 16" day of May, 1904.

ALFRED SCHWARZ

TO ALL WHOM IT MAY CONCERN, be it known that I, Alfred Schwarz, a subject of the Emperor of Germany and a resident of the Borough of Manhattan, City, County and State of New York, have invented certain new and useful improvements in the PROCESS OF CONCENTRATING ORES of which the following is a specification.

My invention has for its object the concentration
May 10/05 of ~~of~~ ores by the selective action of ~~an oily liquid~~ a hydrocarbon compound. Heretofore the separation of the values in ores has been effected by mixing the pulverized ore with a product resulting from the distillation of petroleum, the ore having been previously mixed with sufficient water to form a freely flowing pulp. The oil in such method exercises the property of attaching itself to and buoying up the metallic constituents of the ore that are suspended in the pulp, but it has little or no effect upon the earthy constituents.

I have found that the efficiency of the selective action of oils generally, either mineral, vegetable or ani-

Defendant's Exhibit.

mal, is increased by the addition thereto of a fatty matter which is solid at normal temperatures as paraffin, stearin or palmitin.

In carrying out my invention I proceed as follows: the ore is first crushed and screened to a convenient size for working and is then thoroughly and intimately mixed with the selective material which in this instance is a compound of a mineral, vegetable or animal oil and a fatty matter of the character above
such mixture being solid at normal temperatures materi
1905 specified. Such ~~matter~~ may be readily prepared by dissolving the fatty matter in the oil medium, heat being employed to melt the fatty matter, if necessary, and to maintain the compound in a liquid condition during its incorporation with the pulverized ore. As a specific example of a selective material I prefer crude petroleum, or any of its products to which is added about 9 to 10% by weight of paraffin, such proportion having been found to give good results with a copper sulphide ore.

Any suitable apparatus may be employed to effect the mixture of the ore and selective material, all that is essential being a vessel provided with agitating blades. In such vessel the ore is mixed with sufficient of the

P. 1905, L. 27, insert "into intimate contact will all portions of the ore. The Vessel may be steam jacketed, or otherwise suitably heated, if found necessary to maintain the selective material," after "material"

... ... by suitably arranged pipes, and agitation continued until the water is distributed throughout

Defendant's Exhibit.

and he hereby appoints Charles S. Jones of 141 Broadway in the said City, County and State of New York, his attorney, with full power of substitution and revocation, to prosecute this application, to make alterations and amendments therein, to sign the drawings, to receive the patent and to transact all business in the Patent Office connected therewith.

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the earthy constituents.

I have found that the efficiency of the selective action of oils generally, either mineral, vegetable or ani-

Defendant's Exhibit.

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Any suitable apparatus may be employed to effect the mixture of the ore and selective material, all that is essential being a vessel provided with agitating blades. In such vessel the ore is mixed with sufficient of the selective material to make a thick pasty mass, the agitation being continued long enough to bring the selective material in a liquid condition. After a complete incorporation of the selective material with the ore, water, preferably under pressure, is injected into the mass by suitably arranged pipes, and agitation continued until the water is distributed throughout

the mass. The mass is then allowed to subside when the selective material with the entrapped metallic constituents of the ore will rise to the top and may be removed in any suitable manner as by floating over the top of the vessel. The values may be separated from the selective material in any suitable or well known manner as, for example, by a centrifugal drum or filter press. The tailings being unaffected by the selective material, will remain in the water and settle to the bottom of the vessel from which they may be drawn off, and if necessary, subjected to further treatment for the recovery of any values they may contain.

In the concentration of ores by the selective action of the compound above described the action is facilitated and better results secured by the injection of a gaseous fluid such as air, steam or gas, as carbon dioxide gas, into the mass. This may be done by suitably arranged pipes leading into the bottom or sides of the vessel, the effect of such use of air, steam or gas being to break up and subdivide the mass in a complete and thorough manner. Furthermore it results in the selective material taking up an appreciable quantity of air or gas, giving a certain amount of sponginess which increases its floating power. After the admission of water, which may be done by suitably arranged pipes, the admission of air, steam or gas may be continued to assist in distributing the water throughout the mass and to effect thorough separation and washing out of the tailings.

May 10/05

In referring to paraffin as a fatty matter it is to be understood that I do so in a popular and not a chem-

Defendant's Exhibit.

ical sense. It is also to be understood that the proportions of the ingredients of the selective material may be varied to suit the particular ore treated.

What I claim and desire to secure by Letters Patent is:—

1. A selective material for use in the concentration of ores consisting of a mixture of an animal, vegetable or mineral oil, and a fatty matter which is solid at normal temperatures.

2. A selective material for use in the concentration of ores consisting of a mixture of petroleum or any of its products and paraffin.

3. A selective material for use in the concentration of ores consisting of a mixture of petroleum or any of its products and 10% by weight of paraffin.

1. 4. The method of concentrating ores which consists in mixing with the pulverized ore a selective material consisting of an animal, vegetable or mineral oil and a fatty matter which is solid at normal temperatures, then separating said material with the entrapped values from the tailings, and then separating the values from the selective material.

2. 5. The method of concentrating ores which consists in mixing with the pulverized ore a selective material consisting of an animal, vegetable or mineral oil and a fatty matter which is solid at normal temperatures, then introducing water into the mass to effect a separation of said material with the entrapped values from the tailings, and then separating the values from the selective material.

Defendant's Exhibit.

~~3.~~ 6. The method of concentrating ores which consists in mixing with the pulverized ore a selective material consisting of an animal, vegetable or mineral oil and a fatty matter which is solid at normal temperatures, subjecting the mass to the action of air, steam or gas, then separating said material with the entrapped values from the tailings, and then separating the values from the selective material.

4. 7. The method of concentrating ores which consists in mixing with the pulverized ore a selective material consisting of an animal, vegetable or mineral oil and paraffin, then sepaarting said material with the entrapped values fro mthe tailings, and then separating the values from the selective material.

5. 8. The method of concentrating ores which consists in mixing with the pulverized ore a selective material consisting of an animal, vegetable or mineral oil and paraffin, then introducing water into the mass to effect a separation of said material with the entrapped values from the tailings, and then separating the values from the selective material.

Insert A
July 2/04

IN TESTIMONY WHEREOF I have hereunto signed my name in the presence of two subscribing witnesses:

ALFRED SCHWARZ

Witnesses:

E. F. PORTER

CHARLES S JONES.

Defendant's Exhibit.

STATE OF NEW YORK } ss:
COUNTY OF NEW YORK }

ALFRED SCHWARZ, the above named petitioner, being duly sworn deposes and says that he is a subject of the Emperor of Germany and a resident of the Borough of Manhattan, City, County and State of New York; that he verily believes himself to be the original, first and sole inventor of the improvement in the PROCESS OF CONCENTRATING ORES described and claimed in the annexed specification; that he does not know and does not believe that the same was ever known or used before his invention or discovery thereof, or patented or described in any printed publication in any country before his invention or discovery thereof, or more than two years prior to this application, that said invention has not been patented to him or to others with his knowledge or consent in this or any foreign country for more than two years prior to this application; or on an application for a patent filed in any country foreign to the United States by him or his legal representatives or assigns more than twelve months prior to this application, and that no application for patent on said improvement has been filed by him or his legal representatives or assigns in any country foreign to the United States.

ALFRED SCHWARZ

SWORN TO AND SUBSCRIBED before me this 16th day of May, 1904.

E. F. PORTER
Notary Public, No. 58 Kings Co.
[SEAL.] Certificate filed in N. Y. Co.

Defendant's Exhibit.

M. E. C. 2—260.

Div. 25 Room 315 Paper No. 1

Address only "The Commissioner of Patents, Washington, D. C."

All communications respecting this application should give the serial number, date of filing, and title of invention.

DEPARTMENT OF THE INTERIOR,

UNITED STATES PATENT OFFICE

WASHINGTON, D. C., June 27, 1904.

ALFRED SCHWARZ, Mailed " " "

Care Chas. S. Jones,

New York City.

Please find below a communication from the EXAMINER in charge of your application. #210,138, filed May 27, 1904, for Process of Concentrating Ores.

F. I. ALLEN,

Commissioner of Patents.

Applicant is required to supply a drawing illustrating a means for carrying out his process.

Division is required, in advance of action upon the merits of the claims, between the process and the product claims. To justify joinder of both product and process claims in one application, the process claimed must be one for the preparation or production of the product claimed. The process in this case is for a *use*

Defendant's Exhibit.

of the product claimed, and not for the production of the product.

LEWIS B. WYNNE
Examiner,
Division XXV.

T. F. MITCHELL

Serial No. 210,138 Paper No. 2

Mail Room Patent Office
Jul 2 1904 Jul 5 1904
U. S. Patent Office. Division XXV.

Room 315.
Application of Alfred Schwarz.
Serial No. 210,138.
Filed May 27, 1904.
For Process of Concentrating Ores.

HON. COMMISSIONER OF PATENTS,
Washington, D. C.

Sir:—

Replying to the Examiner's letter of June 27, 1904, please amend the above claims:—

Add the following ~~claims~~:— case as follows :—

A

C celed 10/05

~~6.~~ 9. The method of concentrating ores which consists in mixing with the pulverized ore a selective material consisting of petroleum or a product thereof and paraffin, then separating said material with the entrapped values from the tailings, and then separating the values from the selective material.

Defendant's Exhibit.

~~7.—10. The method of concentrating ores which consists in mixing with the pulverized ore a selective material consisting of petroleum or a product thereof and about 10 percent by weight of paraffin, then separating said material with the entrapped values from the tailings, and then separating the values from the selective material.~~

Remarks.

Claims 1, 2 and 3 of the present application are for a material for use in the concentration of ores and for that purpose only. Rule 41 clearly recognizes the right of applicant to claim in one application distinct inventions which are dependent upon each other and mutually contribute to produce a single result. That is the precise situation with the present claims. None of the specific clauses of Rule 41 prohibit the joinder in one application of claims for a method and claims for a material used in carrying out that method, nor is applicant aware of any ruling of the Commissioner which prohibits such joinder. A patent issued with the present claims would certainly not be invalid on the ground that the inventions are independent within the meaning of Rules 41 and 42.

If the Examiner insists upon his requirement for division, he is requested in accordance with the usual practice of the Office, to give applicant the benefit of a cursory examination in order to enable him to properly divide.

The drawing requested by the Examiner will be furnished in due time.

Defendant's Exhibit.

A reconsideration and allowance of the case is requested. Respectfully submitted,

CHARLES S. JONES
Att'y for Applicant.

Dated New York City, N. Y., July 1, 1904.

2–260

M. E. C.

Div. 25 Room 315 Paper No. 3

Address only "The Commissioner of Patents, Washington, D. C."

All communications respecting this application should give the serial number, date of filing, and title of invention.

DEPARTMENT OF THE INTERIOR

UNITED STATES PATENT OFFICE

WASHINGTON, D. C., July 12, 1904.

ALFRED SCHWARZ, MAILED " "
Care Chas. S. Jones,
New York, N. Y.

Please find below a communication from the EXAMINER in charge of your application. #210,138, filed May 27, 1904, for Process of Concentrating Ores.

F. I. ALLEN,
Commissioner of Patents.

Case as brought up by amendment and argument filed July 2, 1904, considered.

Defendant's Exhibit.

The requirement for division is repeated and made final. See ex parte Tchirner, C. D., 1901, 141.

References were not cited in the first office letter partly because the independence of the inventions appeared so clear, (ex parte Reid, C. D., 1901, 123,) and partly because applicant's attorney already possessed the data available to the examiner, as exhibited at personal interview between attorney and examiner just prior to the filing of this application. However, the following are cited: 348,157, Everson, Aug. 24, 1886, Metallurgy, Reducing, Refining, Separating, 471174, Hebron & Everson, March 22, 1892; 575,669, Robson, Jan. 19, 1897; and 676,679, Elmore, June 18, 1901, Washers, H.

Applicant's response should either cancel the claims to one invention or take the question of division before the Hon. Examiner-in-Chief on appeal.

Lewis B. Wynne
Examiner,
Division XXV.

T. F. Mitchell

Defendant's Exhibit.

Serial No. 210,138 Paper No. 4

Mail Room
Jul 22 1904
U. S. Patent Office.

Patent Office,
Jul 23 1904
Division XXV.

Room 315.

Application of Alfred Schwarz.
Serial Number 210,138.
Filed May 27, 1904.
Process of Concentrating Ores.

HON. COMMISSIONER OF PATENTS,

Sir:—

Replying to the Examiner's letter of July 12, 1904, please amend the above application as follows:

Cancel claims 1, 2 and 3 and change the ordinals of the remaining claims accordingly.

REMARKS.

The above amendment restricts the present application to the method of concentrating ores. Claims 1, 2 and 3 have been canceled without waiver of the right to present them in a separate application.

An early action on the merits is requested.

Dated NEW YORK, July 21, 1904.

Respectfully submitted,

CHARLES S. JONES,
Atty. for Applicant.

Defendant's Exhibit.

2-260

M. E. C.

Div. 25 Room 315 Paper No. 5

Address only "The Commissioner of Patents, Washington, D. C."

All communications respecting this application should give the serial number, date of filing and title of invention.

DEPARTMENT OF THE INTERIOR

UNITED STATES PATENT OFFICE

WASHINGTON, D. C., Aug. 16, 1904
MAILED " " "

ALFRED SCHWARZ,
Care Chas. S. Jones,
New York City.

Please find below a communication from the EXAMINER in charge of your application. #210,138, filed May 27, 1904, for Process of Concentrating Ores.

F. I. ALLEN
Commissioner of Patents.

Case as amended July 22, 1904, further considered.

Claim 1 is objectionably alternative by reason of "animal, vegetable or mineral oil," line 3. The claim is rejected as failing to express anything patentable over 348,157, Everson, of record. See page 2, lines 71-74. The mixture of petroleum with tallow and

Defendant's Exhibit.

the procedure indicated for the separation completely anticipate this claim.

Claim 2 is alternative in the same manner as claim 1 and is rejected upon the same reference.

Claim 3 is alternative in the same manner as claim 1 and also by reason of "air, Steam or gas", line 5. Said claim is rejected in view of Everson, of record, and 745,960, Good, Dec. 1, 1903, Washers, H,—see 32a thereof—or British patent 12,778, Lake, June 4, 1902, Washers.

Claims 4 and 5 are objectionably alternative in the same manner as claim 1, and are rejected upon the same reference.

Claims 6 and 7 are alternative as to "petroleum or a product thereof". They do not express anything patentable over Everson or Elmore of record, for the reason that Elmore's product ("residuum") is a mixture of petroleum or a product thereof and paraffin.

LEWIS B. WYNNE

T. F. Mitchell Examiner, Div. XXV.

Defendant's Exhibit.

Patent Office Serial No. 210,138 Paper No. 6
May 10 1905
Division XXV.

Room 315.

Application of Alfred Schwarz.
Serial No. 210,138.
Filed May 27, 1904.
Process of Concentrating Ores.

Hon. Commissioner of Patents,
Washington, D. C.

Sir:—

Replying to the Examiner's letter of August 16, 1904, please add the accompanying sheet of drawings.

Page 1 of the specifications, line 2, cancel "an oily liquid" and substitute therefore "a hydrocarbon compound".

Same page, line 22, after "specified" insert "such mixture being solid at normal temperatures".

Page 2, line 2 from the bottom, before "air" insert "a gaseous fluid such as".

At the end of the specification, page 3, add the following:—

B "The accompanying drawing shows in perspective one arrangement of apparatus by which the process may be carried out. 1 designates a bin or hopper from which the pulverized ore is discharged into a vessel 2 which is preferably steam jacketed and pro-

vided with an agitator 3. In this vessel the ore and selective agent are intimately mixed, and from said vessel the mass is discharged into a vessel 4 provided with an agitator in which it is treated with water slightly acidulated if desired to effect the separation of the selective agent with the entrapped metallic constituents from the tailings. If cold water is employed the selective agent will be solidified and rising to the top is conducted by a trough 5 to remeltin and storage vessel 6. If heated or boiling water is employed in the vessel 4 the selective agent will be maintained in its liquid condition, and as it rises with the entrapped metallic constituents is run by the trough 5 into the storage vessel 6, and from the latter to a centrifugal drum 7 for the separation of the values from said agent. The recovered agent is collected in a storage vessel 8 from which it may be raised to the mixing vessel 2 by a pump 9. The separating vessel 4 is provided with suitable pipes 10 for the admission of air, steam or gas and with a pipe 11 by which the tailings may be discharged into a vessel 12. After removal of the values from the separator 7 they may be subjected to any suitable treatment.

Cancel the present claims and substitute therefor the following:—

"1. The process of concentrating ores consisting in mixing with the pulverized ore a selective agent consisting of a mixture of a liquid hydrocarbon and a normally solid fatty matter which mixture is solid at

normal temperatures, separating said agent with its entrapped values from the tailings, and finally recovering the values from the selective agent.

2. The process of concentrating ores consisting in mixing with the pulverized ore a selective agent consisting of a mixture of liquid hydrocarbon and a normally solid fatty matter which mixture is solid at normal temperatures, treating the mass with water to separate said agent with its entrapped values from the tailings, and finally recovering the values from the selective agent.

3. The process of concentrating ores consisting in mixing with the pulverized ore a selective agent consisting of a mixture of liquid hydrocarbon and a normally solid fatty matter which mixture is solid at normal temperatures, treating the mass with cold water to separate said agent with its entrapped values from the tailings, and finally recovering the values from the selective agent.

4. The method of concentrating ores consisting in mixing with the pulverized ore a selective agent consisting of a mixture of a liquid hydrocarbon and a normally solid fatty matter which mixture is solid at normal temperatures and subjecting the mass to the action of a gaseous fluid, separating the selective agent with its entrapped values from the tailings, and finally recovering the values from the selective agent.

5. The process of concentrating ores consisting in mixing with the pulverized ore a selective agent consisting of a mixture of a liquid hydrocarbon and paraffin

Defendant's Exhibit.

which mixture is solid at normal temperatures, separating said agent with its entrapped values from the tailings, and finally recovering the values from the selective agent.

6. The process of concentrating ores consisting in mixing with the pulverized ore a selective agent consisting of a mixture of a liquid hydrocarbon and paraffin which mixture is solid at normal temperatures, treating the mass with water to separate said agent with its entrapped values from the tailings, and finally recovering the values from the selective agent."

Remarks.

The above amendments have been made in accordance with the Examiner's letter of August 16th, 1904, and in view of a recent personal interview. The claims as now drawn, it is thought, avoid the references of record as they are modeled after patent 771,277 issued to the Schwarz Ore Treating Company, the owner of the present application.

Patent to Everson 348,157 is for the use of emulsions of fats and oils thickened or acidulated by chemical reagents, the silica being removed by a subsequent washing operation. The present claims are restricted to the use of an agent consisting of a mixture of a liquid hydrocarbon and a normally solid fatty matter which mixture is solid at normal temperatures.

Patent to Good 745,960 mentions in one place the

use of oil. No where, however, does Good state why the oil is added or what function it performs.

None of the Elmore patents disclose the present specific selective agent.

A reconsideration and allowance of the case is requested.

Respectfully submitted,

CHARLES S. JONES,
Atty for applicant

Dated New York City, N. Y., April 28, 1905.

ASW 2—181. Serial No. 210,138

Issue Division.

All communications should be addressed to "The Commissioner of Patents, Washington, D. C."

DEPARTMENT OF THE INTERIOR,

U. S. PATENT OFFICE,

WASHINGTON, D. C., July 6, 1905

ALFRED SCHWARZ, Assor
C/o Chas. S. Jones
141 Broadway
New York, N. Y.

Sir:—Your Application for a patent for an IMPROVEMENT IN PROCESS OF CONCENTRATING ORES Filed May 27, 1904, has been examined and ALLOWED.

Defendant's Exhibit.

The final fee, Twenty Dollars, must be paid, and the Letters Patent bear date as of a day not later than SIX MONTHS from the time of this present notice of allowance.

If the final fee is not paid within that period the patent will be withheld, and your only relief will be by a renewal of the application, with additional fees, under the provisions of Section 4897, Revised Statutes. The Office aims to deliver patents upon the day of their date, and on which their term begins to run; but to do this properly applicants will be expected to pay their final fees at least TWENTY DAYS prior to the conclusion of the six months allowed them by law. The printing, photolithographing, and engrossing of the several patent parts, preparatory to final signing and sealing, will consume the intervening time, and such work will not be done until after payment of the necessary fees.

When you send the final fee you will also send, DISTINCTLY AND PLAINLY WRITTEN, the name of the INVENTOR and TITLE OF INVENTION AS ABOVE GIVEN, DATE OF ALLOWANCE (which is the date of this circular), DATE OF FILING, and, if assigned, the NAMES OF THE ASSIGNEES.

If you desire to have the patent issue to ASSIGNEES, an assignment containing a REQUEST to that effect, together with the FEE recording the same, must be filed in this Office on or before the date of payment of final fee.

After issue of the patent uncertified copies of the

Defendant's Exhibit.

drawings and specifications may be purchased at the price of 5 cents each. The money should accompany the order. Postage stamps will not be received.

Respectfully,

F. I. ALLEN,

Commissioner of Patents.

After allowance, and prior to payment of the final fee, applicants should carefully scrutinize the description to see that their statements and language are correct, as mistakes not incurred through the fault of the office, and not affording legal grounds for reissues, will not be corrected after the delivery of the letters patent to the patentee or his agent.

In remitting the final fee give the serial number at the head of this notice.

If payment is made by check or draft, the credit allowed is subject to the collection of the same.

Defendant's Exhibit.

2—103.

$20 received as the final fee in the application of A Schwarz 210138 for Process of Concentrating Ores applied from a composite letter No. 219761 received Nov. 25 1905 from Jones C S which is on file in the Chief Clerk's room. B/MR J W Babson

J J D Chief of Issue and Gazette Division.

SM

Issue Division. 2—191. Serial No. 210,138

Address only "The Commissioner of Patents, Washington, D. C."

DEPARTMENT OF THE INTERIOR

UNITED STATES PATENT OFFICE

Washington, D. C., Nov. 25, 1905.

Alfred Schwarz, Assor.,
C/o Chas. S. Jones,
141 Broadway,
New York, N. Y.

Sir:

You are informed that the final fee of twenty dollars has been received in your application for Improvement in Process of Concentrating Ores.

Very respectfully

F. I. Allen

Commissioner of Patents.

[Here follows printed copy of Patent 807,503.]

Defendant's Exhibit.

1904 | 83. Mills Ore and Coal Washers.

CONTENTS:

Print

Application ———papers.

1. Letter ÷ June 27, 1904.
2. Amendment A July 2, 1904.
3. Letter ÷ July 12, 1904.
4. Amendment July 22, 1904.
5. Rej. Aug. 16, 1904.
6. Amendment B. May 10, 1905.
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12.
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18.
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20.
21.
22.
23.

TITLE:

Improvement in Process of Concentrating Ores

Defendant's Exhibit.

Defendant's Exhibit Certified Copy of File-Wrapper and Contents of Kirby Patent No. 809,959.

UNITED STATES OF AMERICA,

DEPARTMENT OF THE INTERIOR,

UNITED STATES PATENT OFFICE

To all to whom these presents shall come, Greeting:

THIS IS TO CERTIFY that the annexed is a true copy from the Records of this Office of the File Wrapper and Contents, in the matter of the Letters Patent of Edmund B. Kirby, Number 809,959, Granted January 16, 1906, for Improvement in Processes of Separating Minerals.

IN TESTIMONY WHEREOF I have hereunto set my hand and caused the seal of the Patent Office to be affixed at the City of Washington, this 3rd day of June, in the year of our [SEAL.] Lord one thousand nine hundred and twelve and of the Independence of the United States of America the one hundred and thirty-sixth.

F A TENNANT

Acting Commissioner of Patents.

Defendant's Exhibit.

2–437

Number (Series of 1900). Div 25

185,033 1903 (Ex'r's Book). 38-115

Patent No. 809,959 Div'n XXV.

Name Edmund B. Kirby,

of Rossland

Province of British Columbia,

Canada

Division of App., No. , filed , 190

Invention Process of Separating Minerals

Parts of application filed.	Original.	Renewed.
Petition	Dec. 14, 1903	, 190
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1 " " Cert.	, 190	, 190
Appl. filed complete	Dec. 14, 1903	, 190

Examined Lewis B. Wynne Ex	June 29th, 1905	, 190
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Associate Attorney Attorney Thurston & Bates
1028 Society for Savings B'ld'g,
Cleveland, Ohio.

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Patent No. Date of Patent

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$15 Received
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Chief Clerk, U. S. Patent Office.

CLEVELAND, OHIO., Dec. 12, 1903.

COMMISSIONER OF PATENTS,
Washington, D. C.

Dear Sir:—

In the matter of the application about to be filed by Edmund B. Kirby for Process of Separating Minerals executed Dec. 4, 1903, we hand you herewith by mail the following:—

Petition and Power of Attorney,
Specification,
Oath,
3 Sheet of Drawings.
Government Fee: $15.00, enclosed in our check.

Your truly,
THURSTON & BATES

Mail Room Serial No. 185,033 Paper No. ½
Dec 14 1903 Application. 1903.
U. S. Patent Office.

TO THE COMMISSIONER OF PATENTS:

Your petitioner, Edmund B. Kirby, a citizen of the United States, residing at Rossland, in the Province of British Columbia and Dominion of Canada, whose Post Office address is Rossland, British Columbia, Canada, prays that Letters Patent may be granted to

him for the improvement in PROCESS OF SEPARATING MINERALS, set forth in the annexed specification.

And he hereby appoints the firm of Thurston & Bates, (Reg. #1130), of Cleveland, Ohio, (said firm consisting of E. L. Thurston and Albert H. Bates) his attorneys, with full power of substitution and revocation, to prosecute this application, to make alterations and amendments therein, to sign the drawings, to receive the patent, and to transact all business in the Patent Office connected therewith.

Signed at Northport, in the County of Stevens and State of Washington, this fourth day of Dec 1903

EDMUND B KIRBY

To all whom it may concern:

SPECIFICATION.

Be it known that I, Edmund B. Kirby, a citizen of the United States, residing at Rossland, in the Province of British Columbia and Dominion of Canada, have invented a certain new and useful improvement in PROCESS OF SEPARATING MINERALS, of which the following is a full, clear and exact description, reference being had to the accompanying drawings.

The invention relates to the concentration of ores. It may be employed to separate the metallic minerals from the gangue or to separate certain of the metallic minerals from others, or from others and the gangue. The operation of the process is dependent upon the fact that, because of differences in physical character-

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istics of the various constituents of mineral material, such constituents show preferences of adhesion between two commingled, but immiscible liquids.

The invention consists in the process hereinafter described, and in the several steps thereof,—all of which will be definitely set forth in the claims.

In the drawings, figure 1 is a diagrammatic view of an apparatus with which the process may be practiced,—the several parts thereof being shown in vertical section; figure 2 is a plan view of one side of the separating tank; figure 3 is a vertical sectional view of the same mechanism; figure 4 is an elevation of a part of the agitator mechanism of the separating tank,—some of said mechanism being in section; and figure 5 is a plan view of one of the agitator arms, and a sectional plan view of the shaft.

The process is applicable to a great variety of ores, and may be practiced, in many cases, so as to separate those metallic minerals which must be treated in one way from those which must be treated in some other way in order to recover their contained commercial metals; and, since it is capable of being used for this purpose as well as to separate the metallic minerals from the gangue, it is thought to be a great step in advance of this art.

It is believed that the process or some of the novel steps thereof may be employed with advantage in the treatment of all ores. It is obviously impossible, however, to give definite directions for attaining the best results with all ores, because of the great chemical and

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physical differences which they exhibit. The detailed directions hereinafter set forth are those which are found most efficient in the treatment of the Rossland, B. C. ores, with which I have done the most work, for the primary purpose of separating the chalcopyrite (which must be smelted) from the other constituents which may be subjected to other after treatment for the recovery of their contained metals.

The process, as an entirety, in its best form for use with Rossland ores for the purpose stated, consists in the following steps.

First, in thoroughly agitating together (a) the pulverized ore or mineral material, (b) enough water to make with said pulverized ore a flowing pulp, and (c) a solution of bitumen in a thin distillable hydro-carbon liquid as kerosene;—these materials to be so thoroughly agitated together as to finely subdivide said solution into small globules, and bring said globules into contact with substantially all of the pulverized mineral particles which will, by preference, adhere to them.

Second, in allowing the hydrocarbon coated particles to float to the surface of the mass, and in rendering this separation substantially complete by gently agitating the mass, and by injecting gas into the same, and, preferably also discharging into the mass fine streams of the solution. When the separation is completed the floating hydrocarbon coated concentrate is removed for subsequent treatment.

Third in filtering said concentrate to free it so far as possible, from the hydrocarbon liquid.

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Fourth, in distilling said coated concentrate, and condensing the hydorcarbon vapor, to be used again.

It is thought that the use of a gas to assist in the flotation of the coated particles, as set forth in the description of the second step of the process, is radically new in this art, irrespective of its association with the other steps described. It is that which makes it possible for the first time to use thin oils and hydrocarbon. The prior processes which use thick, viscous oils will, however, be much aided by the addition of this step, because, in spite of all the care which is exercised in the practice of those processes to keep the oil in large clots or masses, a great deal of it is "floured" or broken up into minute particles which are trapped in the sands and lost. The employment of the gas in the manner stated brings in a more powerful floating agency than anything before used, which results in the recovery of this "floured" oil together with numerous coated particles which would not otherwise be floated. This step of the process is therefore useful with any and all liquids lighter than water which exhibit preference of adhesion for the metalic mineral particles. Kerosene alone for example may be used with most ores to take out the sulphides, provided the gas is used as stated to cause the flotation of the kerosene coated particles.

It is the bitumen, however, dissolved in the kerosene which gives the precise adhesive preference which enables it to separate the gold and chalcopyrite from the crushed ore. The bitumen may be asphalt, or the

bitumen produced by the distillation of petroleum to a semi-solid residuum; or it may be tar, pitch, or any other specific form of bitumen. In treating Rossland ores I have found that the most satisfactory results have been attained by using a solution obtained by dissolving in kerosene above 5 per cent, or thereabout, of Trinidad asphalt, or the semi-solid residuum of petroleum distillation. Preferably the pulverized ore is mixed with three to five times as much water, by weight, and to this is added a sufficient amount of the kerosene-bitumen solution; excellent results being obtained by using one-fourth to three-fourths as much, by weight, as ore.

The preference of the solution ~~of~~ for some of the mineral particles may be regulated by altering or varying the quantity of the solute substance, and by varying the temperature at which the solution is used. The preference of the water for other mineral particles may be regulated by adding some acid or other chemical. A distinct advantage of using a light hydrocarbon, like kerosene, is that so much of it as cannot be re-~~covered~~ moved from the concentrate by mechanical means may be recovered by a process of distillation,—this method of recovery being impossible when thick non-distillable oils are used.

The injection of a gas, preferably air, into the mass, —which is the chief novel characteristic of the second step of the process, assists in the flotation of the hydrocarbon coated particles. This makes it possible to finely subdivide the solution by the agitation, and

this greatly increases the chance that all of the mineral particles which exhibit preferential adhesion for it, shall be brought into contact with it. Some of the hydrocarbon coated particles will float to the surface without assistance; but, a considerable quantity of such particles will not be sufficiently buoyant and some of such particles and some globules of the mixture would be trapped in the sands. In order to recover this less buoyant material together with the globules of the mixture, the mass, which tends to settle, is slowly lifted and turned over to liberate the coated particles, and the globules, and, at the same time a gas, preferably air, is blown into the mass, preferably near the bottom thereof. The air bubbles not only tend to attach themselves directly to the coated particles and thus float them to the surface, but the air becomes dissolved in the water to its maximum capacity. This dissolved air tends to again separate itself from the water, and attach itself in minute globules to the coated particles. I find that air, carbon dioxide, hydrogen, and mash gas are satisfactory for this purpose; and doubtless many other or all gases will operate in the same way,—but I prefer air.

It might be here added that because the solution is broken up into small globules there is little likelihood that any of the non-coated particles shall be entangled with the coated concentrates and carried to the surface.

In removing this floating, hydro-carbon-coated concentrate it is practically impossible to exclude some of

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the water in which the non-coated particles are held in suspension. It is therefore desirable that this concentrate shall be washed free from such non-coated minerals. This step is not, however, absolutely essential. It is possible to remove a very large part of the hydrocarbon by filtration because of its thin character. It is not, however, possible to remove it all by this, or any other mechanical process; but because of the character of the hydrocarbon solvent used it is possible to recover all of it for future use by a process of distillation which constitutes the fourth step of the complete process.

I will now describe the apparatus shown in the drawing for practically carrying on said process. A represents the mixing tank; B represents the separating tank; C represents the settling tank; D represents the filter, and E another filter which may or may not be used according to circumstances; G represents a settling box or tank into which the liquid from the filter or filters is discharged; H represents the retort furnace; I the dust collector used in connection therewith; J a condenser; K the settling tank in which the condenser discharges the condensed vapor; and M represents a reservoir from which the solution may be fed into the mixing tank and into the separating tank.

In the separating tank B is a vertical shaft b having on its upper end a gear b′ by which it may be rotated. The head of the shaft above the driving gear passes through an oil and air box 1 which remain stationary while the shaft revolves, and is supplied by

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the hydrocarbon pipe (2) and the air pipe (3). The box rests on the rotating shoulder (4) of the shaft, and is held down to a tight joint by the collar (5) and lock nut cap (6). Through the hollow shaft (7) extends a small hydrocarbon pipe (8), the upper end of which is firmly inserted within the upward extension (10) of the shaft, and this central pipe conveys the hydro-carbon. In the stationary box the air enters the annular chamber (11), passing through its open bottom through a set of apertures (12) to the interior of the shaft. The hydrocarbon enters a similar annular chamber (13), from which it passes by aperture (14) into the top of the central hydrocarbon pipe.

The hub and revolving arms are shown in Figs. 4 and 5. The step bearing is supported on a pedestal (15) provided with a wooden block (16) which supports the moving wearing plate (17) of the shaft. Lubricating water under pressure is introduced through the pipe (18), finding its way out from the bearing through side grooves, (50). The sides (19) of the shaft are carried down below the bearing so as to leave an annular space (20) between them and the pedestal. This annular space is intended to constitute an air bell, designed to assist the lubricating water in excluding sand from the bearing. The air supply in it is maintained by a slight stress of air which escapes beneath the bell through the pipe (21).

The air current for the charge passes down through the shaft, passing (as shown by the arrows) through the side channels (22) into the hollow arms (23),

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(23). From each arm it passes out through drop pipes (24) (24).

The hydrocarbon liquid is delivered through small pipes, parallel with said hollow arms, emerging at the
Mar. 24/05 outlets (25) (25). The radially raidally scraping blades (26) (26) are secured to the arms (23), and also the inclined lifting plow (27) at the extremity of the said arms, this being so set as to force the circulation upwards at this point.

The rotary movement of the charge leads the floating scum of hydrocarbon liquid, air bubbles and con-
Mar. 24/05 centrates against the curved spiral skimming bar (28) which is hung so as to arrest and deflect this floating layer and cause it to pass into the settling and washing chamber or box (29). The edge of this box outside of the skimming bar is submerged sufficiently to allow the floating material to pass over it while the remaining part of said edge is raised above the liquid so as to detain everything passing into it. Owing to the agitation within the tank caused by the movement of the arms (23) and the rising air bubbles, the water even near the top is not clear, but turbid or muddy with slimes or fine particles of the non-coated minerals, which do not settle rapidly enough to get out of the way. The floating concentrates are carried mainly at the lower surface of the hydrocarbon layer where it is in contact with the water. The discharge gate (32) in order to permit these floating particles to pass out, must be set low enough to clear them, and must therefore allow portion of the water to pass out with the

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skimmings, and this muddy water would therefore carry its suspended particles of the worthless minerals which would make the concentrates impure.

The settling and washing chamber or box is designed to lessen or prevent this evil. As the floating material passes over its submerged edge (29) (30) it escapes from the swift current and rising air bubbles, so that in its comparative quiet, the slimes have a better opportunity to settle out of the way. The bottom of the box is divided as convenient into compartments by submerged partitions, as shown, each compartment terminating in a hopper shape bottom, with discharge openings (33) through which the settled slimes may pass out again into the tank. Projecting shields (34) prevent the air bubbles from entering the hoppers and disturbing their quiet.

The passage of the floating material over this quiet chamber or box settles most of the slimes before reaching the adjustable discharge gate or outlet (32). Before reaching the gate, however, the skimmings pass over stream of clean wash water, introduced at the point (35) through the pipe shown. This washwater is delivered under constant head from supply tank. Its quantity is made exactly equal to that passing out through the discharge gate with the skimmings; so that this discharge, being supplied entirely by the pure water close at hand, contains little or none of the muddy water which is thus held back in the tank. It is evident that the incoming and outgoing streams are self-adjusting, because if too much enters, the general

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Mar. 24/05 level ~~level~~ rises and a large stream flows from the orifice.

In the mixing tank a vertical rotating shaft *a* is mounted having preferably a lower bearing similar to that which is provided for a shaft b and which has been described. Arms a′ are attached to the shaft near its lower end, and lifting plows are secured to the outer parts of these arms, and radial plows to the other parts thereof just as in the separator tank. This shaft *a* is to be rotated rapidly, and the result is a thorough commingling of the various parts of the charge,—result ~~which~~ is facilitated by the currents created in the charge by the action of said plows,—the direction of said currents being indicated by the arrows in figure 1.

This separate tank for performing the mixing operation is not necessary for my process although it is preferable in some cases as when a continuous discharge is desired. The mixing may be performed just as well in the separating tank which may then be termed the "Mixing and Separating tank". It is merely necessary to rotate the agitating mechanism rapidly while mixing and to rotate it slowly while the separation is being made.

The material skimmed from the surface of the separating tank may pass directly to the filter D or E, but it is best to discharge it into the settling tank C in order to separate the main bulk of water and thus reduce the bulk of liquid to be put through the filtering operation.

As explained, this is not essential, but is conveniently introduced prior to the filtration, merely in order to

separate the main bulk of water, and thus reduce the bulk of fluid to be put through the filtering operation. It is thus merely a convenience. The settling tank C is shown as a cylindrical vessel, with hopper shape bottom, within which is suspended a cylinder (41) reaching half way down. The stream of skimming enters this central cylinder, within which the water and hydrocarbon separate, the former sinking, while the latter, with its accompanying concentrates and air bubbles, floats in a layer, as shown. The stirring apparatus (42) has its arms revolving gently within this layer, so as to break up and discharge air bubbles and assist the separation. Most of the concentrates hang near the contact between the hydrocarbon and water, and as this contact surface becomes overloaded with concentrates, some of them sink to the bottom of the tank. The excess of hydrocarbon, accompanied by some of the concentrates, flows out through the launder (43) while the excess of water, passing beneath the suspended internal cylinder, passes out through the overflow (44), and thereby lessens the volume to be filtered. The concentrates which fall to the bottom of the tank, accompanied by the hydrocarbon which adheres to them, are drawn off in a thick condition through the pipe (45), the discharge end of which is raised to prevent the exit of more water than necessary. The two streams, one of hydrocarbon and concentrates, the other mainly of water and concentrates, may either be filtered in separate apparatus or united and put through the same apparatus, as is

found most convenient. Hydrocarbon liquid and concentrates filter more easily than when water is present, and it may therefore be desirable to filter separately. It is for this reason that two filters D and E are shown,—the one receiving such material as flows from the surface of the tank through launder (43), and the other that material which is discharged through pipe (45). I do not restrict myself to any particular form of filtering appliance.

The use of thin hydrocarbon liquid in place of the thick viscid oil used by other inventors, makes filtration comparatively easy, and permits the use of more simple and cheap methods than the centrifugal machine or filter presses. The use of such simple apparatus is also made possible by the fact that it is not now necessary to separate the liquid very thoroughly, since its extraction is to be perfected in the distillation retorts. I find that in some case it is sufficient to use a simple open filter tank, with a porous bottom of any of the well-known kinds, preferably light canvas resting on suitable supports. The liquid and water drain through the porous bottom, leaving the concentrates in the tank, sufficiently drained to be shoveled into the retorts. The passage of the liquid and water through the porous bottom is aided by the well-known means of a vacuum pump N beneath. The filter indicated by E is a pressure filter barrel of well known construction which need not be here explained, and may be used when forced filtration is necessary. It is shown to emphasize the fact that the operation of the

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process is not restricted to any specific kind of filter, or to any number of filters.

The mixture of hydrocarbon liquid and water, now free from solid matter, is of course self-separating in any receptacle. A convenient form is shown in the settling box G, into which said mixture is delivered through suitable pipes from both filters. The hydrocarbon liquid remains in one compartment g, from which it overflows and is returned to the reservoir. The water, sinking to the bottom, passes under the partition g′ to the other compartment and flows to waste.

The filtered concentrates, containing some residual liquid and moisture, are now ready for the distilling operation, for the recovery of the five per cent or more of valuable hydrocarbon liquid remaining in them. This is done in the retort furnace H. An iron retort (46) is set in a furnace at such an angle that the concentrates will pass down through it by gravity, but will not altogether close the upper side of the channel, which should remain more or less open, for the exit and passage of the steam and hydrocarbon vapors. The retort is maintained at the distillation temperature of the hydrocarbon used, which in the case of kerosene is about 338 degrees F. In order to assist in carrying off the hydrocarbon vapor, a current of superheated steam is introduced at (47), while the steam and hydrocarbon vapors pass off through the pipe at (48) to the condensing apparatus. The dry concentrates on losing their liquid and moisture slide down to the lower end

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of the retort, where they are drawn off through the double gates (49) (49) which are opened alternately so as to prevent the escape of vapors. As concentrates are drawn off below a fresh mass is introduced above, by the alternate opening of the gates (50) (50), which likewise prevent the escape of vapors. An additional seal is provided by the hopper (51) which is kept filled with concentrates. The steam and hydrocarbon vapors may be led through a dust collecting chamber I, designed to settle and collect any concentrates dust carried over, and then passes to the condenser J. This includes a metal worm or coil (53) set in a tank through which a stream of cooling water is allowed to flow. The condensed hydrocarbon and water, passing through a "U" trap (54) flow into a settling box K similar to the one described at "G". Here the hydrocarbon liquid and water separate, and the former is returned to the reservoir M for re-use, as is also the liquid recovered in the settling tank G.

Having described my invention, I claim:

Canceled June 26/05

1. The process of separating minerals, which consists in mixing together (a) pulverized mineral material, (b) a considerable quantity of water, and (c) a substance immicible in water but of less specific gravity, and which, in the presence of water, will adhere to some of the mineral particles and not to others; in removing from the surface of the mass the floating immiscible substance and the mineral particles to which it has adhered; in filtering the material so re-

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moved; and in distilling the concentrate residue ~~filtrate~~ to drive off

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and recover said immiscible substance, substantially as specified.

2. The process of separating minerals, which consists in mixing together pulverized mineral material, a considerable quantity of water, and a substance immiscible in water but of less specific gravity, and which, in the presence of water, will adhere to some of the mineral particles and not to others; in gently agitating the mass and blowing into the same a gas to assist the flotation of said immiscible substance and the mineral particles which have become coated therewith; in removing the floating layer; and separating said adhering substance from said mineral particles, substantially as specified.

1- ~~3~~. The process of separating minerals, which consists in mixing together pulverized mineral material, a considerable quantity of water, and a substance immiscible in water, but of less specific gravity, and which will, in the presence of water, adhere to some of the mineral particles and not to others; in violently agitating the mass so as to break up said immiscible substance into minute globules; in allowing said mass to settle whereby a considerable quantity of

P. 1945, L. 26, insert "gently agitating the portion thereof which settles, and in" after "in"

particles coated therewith; in removing the floating layer, and in separating the mineral particles from said immiscible substance, substantially as specified.

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of the retort, where they are drawn off through the double gates (49) (49) which are opened alternately so as to prevent the escape of vapors. As concentrates are drawn off below a fresh mass is introduced above, by the alternate opening of the gates (50) (50), which likewise prevent the escape of vapors. An additional seal is provided by the hopper (51) which is kept filled with concentrates. The steam and hydrocarbon vapors may be led through a dust collecting chamber I, designed to settle and collect any concentrates dust carried over, and then passes to the condenser J. This includes a metal worm or coil (53) set in a tank through which a stream of cooling water is allowed to flow. The condensed hydrocarbon and water, passing through a "U" trap (54) flow into a settling box K similar to the one described at "G". Here the hydrocarbon liquid and water separate, and the former is returned to the reservoir M for re-use, as is also the liquid recovered in the settling tank G.

Having described my invention, I claim:

Canceled June 26/05 1. The process of separating minerals, which consists in mixing together (a) pulverized mineral material, (b) a considerable quantity of water, and (c) a substance

immiscible substance and the mineral particles to which it has adhered; in filtering the material so removed; and in distilling the concentrate residue ~~filtrate~~ to drive off

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~~and recover said immiscible substance, substantially as specified.~~

~~2. The process of separating minerals, which consists in mixing together pulverized mineral material, a considerable quantity of water, and a substance immiscible in water but of less specific gravity, and which, in the presence of water, will adhere to some of the mineral particles and not to others; in gently agitating the mass and blowing into the same a gas to assist the flotation of said immiscible substance and the mineral particles which have become coated therewith; in removing the floating layer; and separating said adhering substance from said mineral particles, substantially as specified.~~

1- ~~3~~. The process of separating minerals, which consists in mixing together pulverized mineral material, a considerable quantity of water, and a substance immiscible in water, but of less specific gravity, and which will, in the presence of water, adhere to some of the mineral particles and not to others; in violently agitating the mass so as to break up said immiscible substance into minute globules; in allowing said mass to settle whereby a considerable quantity of the mineral particles having become coated with said substance will float to the top of the mass, and in blowing into the same a gas for the purpose of assisting the flotation of said substance and the mineral particles coated therewith; in removing the floating layer, and in separating the mineral particles from said immiscible substance, substantially as specified.

4. The process of separating ores, which consists in thoroughly mixing together pulverized mineral material, a considerable quantity of water, a thin liquid hydrocarbon which will adhere to some of the mineral particles and not to others; in gently agitating the mass and blowing gas into the same for the purpose of assisting the flotation of said hydro-carbon and the mineral particles which have been coated thereby; in removing the floating layer; and separating said mineral particles and hydro-carbon, substantially as specified.

Canceled June 26/05

5. The process of separating ores, which consists in thoroughly mixing together pulverized mineral material, a considerable quantity of water, and a thin hydro-carbon liquid which will adhere to some of the mineral particles but not to others; in gently agitating the mass and blowing gas into the same for the purpose of assisting the flotation of said hydro-carbon liquid and the mineral particles which have become coated thereby; in removing the floating layer; and in filtering the same, substantially as specified.

6. The process of separating ores, which consists in thoroughly mixing together pulverized mineral material, a considerable quantity of water, a thin liquid hydrocarbon which will adhere to some of the mineral particles but not to others; in gently agitating the mass and blowing gas and some of said hydro-carbon liquid into the same for the purpose of assisting the flotation of said hydro-carbon liquid and the mineral particles which have become coated thereby; in removing the floating

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layer; and in filtering the same, substantially as specified.

7. The process of separating ores, which consists in thoroughly mixing together pulverized mineral material, a considerable quantity of water, a distillable hydro-carbon liquid which will adhere to some of the mineral particles but not to others; in gently agitating the mass and blowing gas into the same for the purpose of assisting the flotation of said hydro-carbon and the mineral particles which have become coated thereby; in removing the floating layer; in filtering the same; and

concentrate residue

r. 4/05 finally in distilling the filtrate and condensing the hydro-carbon vapors driven off, substantially as specified.

2- 8. The process of separating ores, which consists in mixing together pulverized mineral material, a considerable quantity of water, and a solution of bitumen in a light hydro-carbon liquid; in violently agitating

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this mixture to break up said solution into fine globules; in allowing the mass to settle, and then gently agitating the same and blowing in gas to insure the flotation of said solution ~~into fine globules; in allowing the mass to settle, and then gently agitating the same and blowing in gas to insure the flotation of said solution~~ and the mineral particles coated thereby; in removing the floating layer; and separating the mineral particles from the solution, substantially as specified.

3- 9. The process of separating ores, which consists in mixing together pulverized mineral material, a

considerable quantity of water, and a solution of bitumen in a light hydro-carbon liquid ; in violently agi-

Insert A
Mar- 24/05

tating this mixture to break up said solution into fine globules; in allowing the mass to settle, and then gently agitating the same and blowing in to it a gas and some of the said solution to insure the flotation of said solution and the mineral particles coated thereby; in removing the floating layer; and separating the mineral particles from the solution, substantially as specified.

4- 10. The process of separating minerals, which consists in mixing together the pulverized mineral material a considerable quantity of water, and a solution of bitumen in a light hydro-carbon liquid; in allowing the same to settle, and removing therefrom the floating layer of said solution and the mineral particles which have been coated thereby; and in filtering the material so removed, substantially as specified.

5- 11. The process of separating minerals, which consists in mixing together the pulverized mineral material, a considerable quantity of water, and a solution of bitumen in a light hydro-carbon liquid ; in gently

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agitating this mixture and blowing gas into the same to assist the flotation of said solution and the mineral particles which have been coated thereby; in removing said floating layer; and filtering the same, substantially as specified.

6- 12. The process of separating minerals which consists in mixing together the pulverized mineral material, a considerable quantity of water, and a solution of bitumen in a distillable hydro-carbon liquid ; in

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allowing the same to settle, and removing therefrom the floating layer of said solution and the mineral particles which have been coated thereby; in filtering the mate-

4/05 rial so removed; and in distilling the concentrate residue ~~filtrate~~ and condensing the hydro-carbon vapors driven off, substantially as specified.

7- ~~13~~. The process of separating minerals, which consists in mixing together the pulverized mineral material, a considerable quantity of water, and a solution of bitumen in a distillable hydro-carbon liquid; in gently agitating this mixture and blowing gas into the same to assist in the flotation of said solution and the mineral particles which have been coated thereby; in removing the floating layer, and filtering the same; and in

4/05 distilling the concentrate residue ~~filtrate~~ and condensing the hydro-carbon vapors driven off, substantially as specified.

8- ~~14~~. The process of separating minerals, which consists in mixing together the pulverized mineral material, a considerable quantity of water, and a solution of bitumen and kerosene; in gently agitating this mixture, and in blowing a gas into the same to assist in the flotation of said solution and the mineral particles which have been coated thereby; and in separating said solution and mineral particles, substantially as specified.

9- ~~15~~. The process of separating minerals, which consists in mixing together the pulverized mineral material, a considerable quantity of water, and a solution of bitumen in kerosene, and in vigorously agitating this mixture so as to break up said solution into minute

globules; in gently agitating said mixture and blowing a gas into the same to assist in the flotation of said solution and the mineral particles coated thereby; in removing the floating layer; in washing and filtering the

Mar- 24/05 same; and finally in distilling the concentrate residue ~~filtrate~~ and condensing the hydro-carbon vapors driven off, substantially as specified.

In testimony whereof, I hereunto affix my signature in the presence of two witnesses.

EDMUND B KIRBY

T L SAVAGE
E G EASTMAN Witnesses.

State of Washington }
County of Stevens } ss.

EDMUND B. KIRBY, the above named petitioner, being duly sworn, deposes and says that he is a citizen of the United States, and a resident of Rossland in the Province of British Columbia and Dominion of Canada, and that he verily believes himself to be the original, first and sole inventor of the improvement in PROCESS OF SEPARATING MINERALS? described and claimed in the annexed specification; that he does not know and does not believe that the same was ever known or used before his invention or discovery thereof; or patented or described in any printed publication in the United States of America or any foreign country before his invention or discovery thereof or more than two years prior to this application;, and that no application for foreign pat-

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ent on said invention has been filed by him or his legal representatives or assigns, in any foreign country.

EDMUND B KIRBY

Sworn to and subscribed before me, this 4th day of December 1903.

JOHN A. KELLOGG

[SEAL.] *Notary Public.*

Notary Public for State of Washington, residing at Northport, Washington.

M. E. C. 2—260

Div. . . . . . . Room No 315 Paper No. 1

Address only "The Commissioner of Patents, Washington, D. C."

All communications respecting this application should give the serial number, date of filing, and title of invention.

DEPARTMENT OF THE INTERIOR

UNITED STATES PATENT OFFICE

WASHINGTON, D. C., January 19, 1904.
Mailed " " "

EDMUND B. KIRBY,
Care Thurston & Bates

globules; in gently agitating said mixture and blowing a gas into the same to assist in the flotation of said solution and the mineral particles coated thereby; in removing the floating layer; in washing and filtering the

Mar- 24/05 same; and finally in distilling the concentrate residue ~~filtrate~~ and condensing the hydro-carbon vapors driven off, substantially as specified.

In testimony whereof, I hereunto affix my signature in the presence of two witnesses.

EDMUND B KIRBY

T L SAVAGE
E G EASTMAN Witnesses.

State of Washington
County of Stevens } ss.

EDMUND B. KIRBY, the above named petitioner, being duly sworn, deposes and says that he is a citizen of the United States, and a resident of Rossland in the Province of British Columbia and Dominion of Canada, and that he verily believes himself to be the original, first and sole inventor of the improvement in PROCESS OF SEPARATING MINERALS? described and claimed in the annexed specification; that he does not know and does not believe that the same was ever known or used before his invention or discovery thereof; or patented or described in any printed publication in the United States of America or any foreign country before his invention or discovery thereof or more than two years prior to

P. 1950, L. 29, insert " or in public use or on sale in the United States for more than two years prior to this application " after colon (:)

Defendant's Exhibit.

ent on said invention has been filed by him or his legal representatives or assigns, in any foreign country.

EDMUND B KIRBY

Sworn to and subscribed before me, this 4th day of December 1903.

JOHN A. KELLOGG

[SEAL.] *Notary Public.*

Notary Public for State of Washington, residing at Northport, Washington.

M. E. C. 2—260

Div. ...... Room No 315 Paper No. 1

Address only "The Commissioner of Patents, Washington, D. C."

All communications respecting this application should give the serial number, date of filing, and title of invention.

DEPARTMENT OF THE INTERIOR

UNITED STATES PATENT OFFICE

WASHINGTON, D. C., January 19, 1904.
Mailed " " "

EDMUND B. KIRBY,
Care Thurston & Bates,
Cleveland, Ohio.

Please find below a communication from the Ex-

Defendant's Exhibit.

AMINER in charge of your application. #185,033, filed December 14, 1903, for Process of Separating Minerals.

F. I. ALLEN.

Commissioner of Patents.

---

50 should be inserted in the drawing. "Raidally", page 8, line 27, should be corrected. It is suggested that "curved" would be more appropriate than "spiral", line 1, page 9. The submergence of the side of the box 29 is required to be illustrated.

Claim 1 fails to express anything patentable over 676,679, Elmore, June 18, 1901, Washers, H, the only distinction being as to the manner of recovering the oil by distillation. The final portion in Elmore appears to be considered too unimportant to warrant special treatment. The question appears to be a purely commercial one, not one calling for invention. See als 521,899, Sutton, June 26, 1894, Metallurgy, Solution and Precipitation, Chlorination.

Claim 2 is rejected in view of Elmore, Sutton, cited, and British patent 12,778, Lake, June 4, 1902, Washers.

Claim 3 is rejected in view of Elmore and Lake, cited.

Claim 4 is rejected in view of Elmore, Lake and 736,381, Glogner, Aug. 18, 1903, Washers, H.

Claim 5 is rejected upon the reference for claim 4, as is also claim 6.

Claim 7 is rejected in view of the references for claim 4, the distilling step being held to be one which would naturally suggest itself to anyone desiring to recover substantially all the oil.

Defendant's Exhibit.

Claim 8 is rejected in view of Elmore, Glogner and Lake. The use of an oil intermediate in composition between that of Elmore and that of Glogner does not appear to call for more than judgment or selection.

Claim 9 is rejected as lacking ~~in~~ invention in view of Elmore and Lake.

Claim 10 is rejected in view of the references for claim 8.

Claim 11 is rejected in view of the references for claim 8, as are also claims 12, 13, 14, 15, the distillation of the oil being considered not to involve invention as has been stated above.

LEWIS B. WYNNE
Examiner,
Division XXV.

T. F. Mitchell

Mail Room
Mar 21 1904
U. S. Patent Office

Patent Office,
Mar 22 1904
Division XXV.
Serial No. 185,033 Paper No. 2

CLEVELAND, OHIO, March 16, 1904.

Room No. 315.

COMMISSIONER OF PATENTS,
Washington, D. C.

Dear Sir:—

In the matter of the application of Edmund B. Kirby for Process of Separating Minerals, filed December 14, 1903, Serial No. 185,033, last Office action January 19, 1904.

Defendant's Exhibit.

After carefully considering the references cited, we find ourselves unable to agree with the examiner's conclusion as to their bearing on the patentability of the process set forth by the various claims; and we here submit our reasons for believing that the claims are patentable over the citations.

The Elmore patent describes a process in which a thick oil is to be used,—said oil being the non-distillable residuum of petroleum distillation. The Elmore process is in practical use in various parts of the world, but this thick residuum oil is always used, care being taken not to break it up into globules, but to maintain it in large clots, as set forth in the patent. The Elmore patent does not specify in what manner the ore is separated from the oil to which it adheres, but, as a matter of fact, the method employed by Elmore in practice is to employ a centrifugal separating machine, which removes a very large percentage of the oil, but nevertheless does not remove it all. There is, therefore, a considerable loss of oil. Elmore does not filter the oil-covered concentrate, because the oil will not pass through a filter; and he does not distill it because it will not distill. One may not infer, therefore, from Elmore's silence as to his method of recovering the oil, that he may have used filteration and distillation, or that it was merely a matter of selection with him whether or not he should use these methods. We, of course, understand that filtration to separate a liquid from a solid is not a process which applicant originated. The recovery of oil by distillation is likewise old,

and certainly no claim pretends to cover either of these processes per se. Applicant, however, is the first ever to have devised a practical process for concentrating ore by means of some substance immiscible in water having preference of adhesion for the mineral particles, and in which, because of the character of immiscible substance so used, it could be recovered in its entirety without any loss, except the loss of the small quantity of bitumen employed, by using the processes of filtration and distillation. We should think there could be no question as to the patentability of those claims in applicant's case, which not only specify filtration and distillation, but which also specify a thin hydro-carbon or kerosene or the kerosene-bitumen solution. It would seem also that such claims, as claim 1, which are not limited to the specific filterable and distillable oil, are likewise allowable, because, as above stated, applicant was the first to devise a practical commercial process in which filtration and distillation could be, and was, used as the method for recovering the concentrating material.

The British patent, mentioned, seems to be for a laboratory experiment; but passing that question, we submit that it is not a sufficient reference for the rejection of any of applicant's claims. The process consists in mixing with the oil some limestone, some water "a thin layer of ordinary oil" and some sulphuric acid. This latter, by getting upon the limestone, generates a gas, and, as a result, the chalcopyrite will instantly rise to the top of the liquid. This process is only in-

tended for the treatment of sulphides. The foregoing is the process as described. The scientific knowledge, upon which the process is based, includes, so the patent stated, the knowledge that if a gas of any kind is *liberated* in this mass the bubbles become covered with a coating of sulphide.

Applicant's is a practical industrial process, not a theory or laboratory experiment. It does not involve the mixture of ore and some material from which a gas may be generated, but it does include the exceedingly practical act of blowing air or some gas, obtained externally of the charge, into the mixture of ore and water and the hydro-carbon solution. Its claims are limited to blowing in the air,—as a result of which the bubbles of air attach themselves like balloons to oil-coated particles and float them to the surface. Applicant's claims *exclude* the flotation of the oil-covered concentrates by *generating* a gas within the charge.

The Sutton patent describes the use of kerosene as a collector of precipitated gold,—gold precipitated from its chlorine solution. What is meant by a collector of precipitated gold is not understood, but the precipitate is in such a finely subdivided condition that possibly kerosene or turpentine might cause it to be collected and floated. It is not pretended, however, by the patentee that the use of kerosene alone would have any substantial or practical effect upon anything else except precipitated gold. This Sutton patent certainly is not an anticipation of any claim in the pending ap-

Defendant's Exhibit.

plication, and can be regarded only as indicating so much as it describes, namely, that the thin hydro-carbon will collect precipitated gold, if introduced into the gold solution before the precipitating sulphate of iron has been added.

The Glogner patent uses petroleum for the purpose of collecting graphite from earthy admixtures therewith. The patent states that it is not useful, unless one first washes out everything except the graphite and the earthy material. Then the petroleum, which the patent directs to be used, is we presume, natural oil which is not a thin oil and contains not only distillable portions, but the non-distillable residuum which Elmore uses. This patent certainly gives no information, by which one could be led to applicant's commercial process of separating the mineral from the non-mineral constituents of crushed ore; and furthermore the patent distinctly states that the process can only be used to collect graphite from a certain admixture therewith.

We presume the examiner is aware of the present activity in various parts of the world of mining engineers and chemists in the matter relating to ore concentration by using oil in different ways. That these skilled men, eagerly and intelligently working in this field, have not found anything in the patents cited to direct them to applicant's process is, we think, a strong argument supporting our view that they do not anticipate applicant's claims. The process described in applicant's process is a practicable, workable and suc-

cessful process,—a statement which cannot be made of any of the processes described in the patents cited in so far as they relate to the separation of the mineral and the non-mineral parts of crushed ore. The examiner must admit that not one of applicant's claims is met by any one of the citations. In this art, particularly it would seem as if the non-patentability of claims should not be predicated upon two or three or more patents, one of which anticipate the claims, upon the theory that one patent shows one of the steps while another shows another of the steps which, in combination, are the subject of applicant's claims.

We request a reconsideration in view of the foregoing, and a favorable action.

Respectfully,

THURSTON & BATES

Attys for

EDMUND B KIRBY

Defendant's Exhibit.

M. E. C. 2—260

Div. 25 Room 315 Paper No. 3

Address only "The Commissioner of Patents, Washington, D. C."

All communications respecting this application should give the serial number, date of filing, and title of invention.

DEPARTMENT OF THE INTERIOR

UNITED STATES PATENT OFFICE

WASHINGTON, D. C., April 23, 1904.
Mailed " " "

EDMUND B. KIRBY,
Care Thurston & Bates,
Cleveland, Ohio.

Please find below a communication from the EXAMINER in charge of your application. #185,033, filed December 14, 1903, for Process of Separating Minerals.

F. I. ALLEN.
Commissioner of Patents.

Case as argued March 21, 1904, further considered.

The 1st claim is rejected in view of Glogner, (taken in connection with the process described on page 344, Vol. XI, Mineral Industry, a copy of which is in the Scientific Library of the U. S. Patent Office. This description refers to *petroleum* vapor which certainly is volatile,) and Elmore. Elmore discloses filter pressing.

Defendant's Exhibit.

While distillation for the recovery of the last traces of oil is not disclosed, it is insisted that it is not a matter of invention in view of the common practice of extracting oil from substances containing them by distillation, and the general practice of distilling amalgam, after straining, for the recovery of the mercury, amalgamation being a very analogous process to oil-separating processes.

It being an old practice to blow gas into pulp to separate material by flotation (see e. g., 469,599, Rouse, Feb. 23, 1892, Washers, A) and the use of gas to aid in the flotation of oil coated particles also being old (Lake of record) it would not appear to involve invention to employ air in the process of e. g., 72~~6~~5,609, Wolfe, Apr. 14, 1903, Washers, H. The 2nd claim is therefore rejected.

Claim 3 is more specific, and, on reconsideration, will be allowed.

Claim 4 is rejected upon the references for the 2nd claim and the reference to Mineral Industry, cited, showing the use of petroleum vapor, which is a thin oil.

The 5th, 6th and 7th claims are rejected upon the references for the first two claims, as expressing mere selections of steps from the prior art without change of relation.

The 8th claim is too indefinite in view of the references for claim 2. The objection lies in the fact that the claim does not specify the relative proportion of oil and bitumen, and the term "solution of bitumen in a light hydrocarbon liquid" may be said to apply to *pe-*

Defendant's Exhibit.

troleum, if the construction contended for by applicant is to be applied to "petroleum".

The same applies to the 9th claim. But it may be said that if applicant specifies the proportions of hydrocarbon liquid and petroleum, the examiner is inclined to favorably consider these two claims.

Claim 10 is rejected as destitute of invention in view of Glogner and Elmore, cited.

What has been said of the 8th and 9th claims applies also to the 11th and 12th.

The 13th, 14th and 15th claims will be allowed.

Applicant would seem to intend that the term "filtrate" apply to the concentrates and their retained oil. If so, the use of the term is incorrect, the term "filtrate" meaning the solution or material passing *through* the filter.

LEWIS B. WYNNE
Examiner,
T. F. Mitchell Division XXV.

Defendant's Exhibit.

Mail Room Patent Office,
Mar 24 1905 Mar 25 1905
U. S. Patent Office Division XXV.

Serial No. 185,033 Paper No. 4

CLEVELAND, OHIO, March 18, 1905.

Room No. 315.

COMMISSIONER OF PATENTS,
Washington, D. C.

Dear Sir:—

In the matter of the application of Edmund B. Kirby for Process of Separating Minerals, filed December 14, 1903, Serial No. 185,033, last Office action April 23, 1904:

Amendment is made as follows:

1. On page 8, line 27 change "raidally" to *radially.*
2. Page 9, line 1, change "spiral" to read *curved.*
3. Page 10, line 13, change "lever" to read *level.*
4. In claim 1, line 9, claim 7, line 9, claim 12 line 7, claim 13 line 8 and claim 15 line 9, change "filtrate" to read *concentrate residue.*
5. Claim 8, line 4, claim 9 line 4, claim 11 line 4, and claim 12 line 4, after the word "liquid", in each instance, insert *the proportion of bitumen in solution being substantially sufficient to insure the coating and entrainment of the mineral particles.*

Respectfully,

E. B. KIRBY
By THURSTON & BATES.
his attorneys)

Defendant's Exhibit.

Remarks:

In connection with the rejection of claim 1, the Examiner's reconsideration of the citation from the Mineral Industry is asked. This article, while possibly being of interest to those engaged in the graphite industry, does not appear to offer the slightest suggestion of value to those who are endeavoring to recover metallic minerals from the gangue. The article referred to, while disclosing the use of a distillable oil, in a particular connection, does not in the slightest manner indicate to any one that it would be possible to make use of a light distillable oil in selecting out metallic values from a pulverized ore. It would be impossible to substitute this step of saturating graphite flakes with petroleum vapor in a mineral separating process, even should it by ~~any~~ chance occur to any one to try it. There surely can be nothing in the discovery of the fact that graphite flakes can be saturated with a vapor of petroleum which would lead one to think that kerosene could be used in a mineral separating process where hitherto thick viscid bitumen alone had been employed. There is no step in Glogner's process which could be substituted by any step in the process described in the Mineral Industry and result in the applicant's process. It seems plain to the applicant that claim 1 should be allowed.

With regard to claim 2 attention is called to the fact that Rouse does not use air for the purpose of assisting in gently agitating and effectually separating those particles which naturally would float to the surface from

those which would naturally sink. Rouse violently drives the fine particles to the surface by sheer force of his air blast, and it is necessary that they should be immediately skimmed off, since they will only float so long as the foam lasts. He, as a matter of fact, has of necessity to create a disturbance in the body of the liquid which would be harmful and detrimental in the applicant's procedure. Lake's process is for a specifically different thing and does not tell the public anything about the advantage of gentl~~ing~~y agitating a mixture of water and mineral particles coated with an immiscible liquid and assisting their separation by blowing in air. Lake discovered that gas bubbles, liberated in the manner which he describes, become coated with chalco-pyrite dust. This discovery is absolutely without value in the applicant's process since the mineral particles are already coated with bitumen, and the public presented is one of separating the bitumen from the water. In connection with the rejection of claim 4 it must be insisted that the article in the Mineral Industry has not contributed anything which is of any assistance in this process.

Claims 5, 6 and 7 have been rejected on the general ground of lack of invention in view of the state of the art. As the applicant understands this theory of rejection, it requires that when the references cited are spread before one the applicant's process shall thereupon become obvious. Now it is submitted that there is no suggestion of the applicant's sequence of steps in the prior art. He is assuredly the first to use the proc-

Defendant's Exhibit.

ess claimed, and finds that it is a distinct step forward, productive of results hitherto not attained, and it seems that it would be a practical denial of his legal rights to refuse him protection on that which is his and his alone. This process is surely not an obvious one; otherwise, being successful, as it is, it would have been previously practiced.

The art to which it relates is one in which experimentation is at once difficult and expensive, and it would seem that whenever an inventor has sufficient confidence in the merits of a new procedure, which he has conceived, to go to the risk and expense necessary to determine the operativeness of the same that the somewhat theoretical question of invention should be decided in his favor.

Claims 8, 9, 11 and 12 have been amended as desired.

Claim 10 it is thought should be allowed on the grounds set forth above. It is understood that the remaining claims are regarded as allowable.

Respectfully,

THURSTON & BATES

Defendant's Exhibit.

M. E. C. 2—260

Div. 25 Room 315 Paper No. 5

Address only "The Commissioner of Patents, Washington, D. C."

All communications respecting this application should give the serial number, date of filing, and title of invention.

DEPARTMENT OF THE INTERIOR

UNITED STATES PATENT OFFICE

WASHINGTON, D. C., May 2, 1905.

EDMUND B. KIRBY,
Care Thurston and Bates,
Cleveland, Ohio.

Please find below a communication from the EXAMINER in charge of your application. # 185,033, filed December 14, 1903, for Process of Separating Minerals.

F. I. ALLEN.
Commissioner of Patents.

Case as amended and argued March 24, 1905, further considered.

Wolfe of record amply discloses the use of kerosene for recovering gold; this taken in connection with Glogner and the reference to Mineral Industry of record amply anticipate the use of a light volatile oil for the recovery of metals. The 1st claim is rejected in view of Wolfe, Elmore of record, and the analogous

Defendant's Exhibit.

process of amalgamation in which mercury is the selective material. In the amalgamation of gold it is the universal practice to strain the amalgam, and subject the residue to distillation to recover the last of the mercury. It would not involve invention to follow the strictly analogous series of steps with oil. See 207,695, Tunbridge, Sept. 3, 1878, (page 2, lines 11-13, 1st column.)

British patent to Lake discloses the use of oil and gas in separating ores. In view of this, it would not involve invention to inject air in Wolfe, in view of Rouse of record, or 751,645, Hopkins, Feb. 9, 1904, Washers, A. The 2nd claim is therefore rejected.

The 4th is rejected upon the references for claim 2.

The 5th, 6th and 7th claims are rejected in view of the references for the first two claims.

The other claims will probably be allowed.

LEWIS B. WYNNE
Examiner, Division XXV.

T. F. Mitchell

Defendant's Exhibit.

Mail Room Jun 26 1905 U. S. Patent Office.

Patent Office, Jun 27 1905 Division XXV

Serial No. 185,033 Paper No. 6

CLEVELAND, OHIO, June 24, 1905.

Room No. 315.

COMMISSIONER OF PATENTS,
Washington, D. C.

Dear Sir:

In the matter of the application of Edmund B. Kirby for Process of Separating Minerals, filed December 14th, 1903, Serial No. 185,033, last Office action May 2, 1905.

Amendment is made as follows:

Cancel claims 1, 2, 4, 5, 6 and 7.

E. B. KIRBY,
By THURSTON & BATES,
Attys.

Defendant's Exhibit.

A. R. 2—181

Issue Division. Serial No. 185,033

All communications should be addressed to "The Commissioner of Patents, Washington, D. C."

DEPARTMENT OF THE INTERIOR

U. S. PATENT OFFICE,

WASHINGTON, D. C., July 10, 1905.

EDMUND B. KIRBY,

% Thurston & Bates,

S. F. S. Bldg. Cleveland. Ohio

Sir:—Your APPLICATION for a patent for an IMPROVEMENT IN Process of Separating Minerals. Filed Dec. 14, 1903, has been examined and ALLOWED.

The final fee, TWENTY DOLLARS, must be paid, and the Letters Patent bear date as of a day not later than SIX MONTHS from the time of this present notice of allowance.

If the final fee is not paid within that period the patent will be withheld, and your only relief will be by a renewal of the application, with additional fees, under the provisions of Section 4897, Revised Statutes. The Office aims to deliver patents upon the day of their date, and on which their term begins to run; but to do this properly applicants will be expected to pay their final fees at least TWENTY DAYS prior to the conclusion of the six months allowed them by law. The printing, photolithographing, and engrossing of the several patent parts, preparatory to final signing and sealing, will

consume the intervening time, and such work will not be done until after payment of the necessary fees.

When you send the final fee you will also send, DISTINCTLY AND PLAINLY WRITTEN, the name of the INVENTOR and TITLE OF INVENTION AS ABOVE GIVEN, DATE OF ALLOWANCE (which is the date of this circular), DATE OF FILING, and, if assigned, the NAMES OF THE ASSIGNEES.

If you desire to have the patent issue to ASSIGNEES, an assignment containing a REQUEST to that effect, together with the FEE for recording the same, must be filed in this Office on or before the date of payment of final fee.

After issue of the patent uncertified copies of the drawings and specifications may be purchased at the price of 5 cents each. The money should accompany the order. Postage stamps will not be received.

Respectfully,

F. I. ALLEN.
Commissioner of Patents.

After allowance, and prior to payment of the final fee, applicants should carefully scrutinize the description to see that their statements and language are correct, as mistakes not incurred through the fault of the office, and not affording legal grounds for reissues, will not be corrected after the delivery of the letters patent to the patentee or his agent.

In remitting the final fee give the Serial Number at the head of this notice.

If payment is made by check or draft, the credit allowed is subject to the collection of the same.

Defendant's Exhibit.

✓ $ 20 Received
Ck Dec 23 1905 Z
Chief Clerk, U. S. Patent Office

CLEVELAND, OHIO, Dec. 21, 1905

COMMISSIONER OF PATENTS,
Washington, D. C.

Dear Sir:—

In the matter of the application of Edmund B. Kirby, for an improvement in Process of Separating Minerals, filed December 14, 1903 Serial No. 185033 allowed July 10, 1905 we hand you herewith as final Government Fee $20.00 in the form of our check.

Yours truly,
from
THURSTON, BATES & WOODWARD,
1029 Society for Savings Building,
CLEVELAND, OHIO.

Defendant's Exhibit.

SM 2—183.

Issue and Gazette Division. Serial No. 185,033

All communications should be addressed to "The Commissioner of Patents, Washington, D. C."

DEPARTMENT OF THE INTERIOR,

UNITED STATES PATENT OFFICE,

WASHINGTON, D. C., Dec. 23, 1905.

EDMUND B. KIRBY,
C/o Thurston, Bates & Woodward,
1028 Society for Savings Bldg.,
Cleveland, Ohio.

Sir:

Your application for a patent for an IMPROVEMENT IN Process of Separating Minerals, filed Dec. 14, 1903, has been examined and again ALLOWED.

The final fee, TWENTY DOLLARS, in the above-entitled case was received Dec. 23, 1905.

Very respectfully,

F. I. ALLEN.

Commissioner of Patents.

[Here follows printed copy of Patent 809,959.]

Defendant's Exhibit.

1903

CONTENTS:

83. Mills,
Ore and Coal
Washers.

Print

Application papers. O.K.

1. Rej. Jan 19 1904
2. Argument Mar 21, 1904.
3. Rej Apr 23 1904
4. Amendment A Mar 24-1905
5. Rej May 2 1905
6. Amendment June 26 1905
7.
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TITLE:

Improvement in Process of Separating Minerals

Defendant's Exhibit.

Defendant's Exhibit Certified Copy of File-Wrapper and Contents of Patent in Suit No. 835,120.

UNITED STATES OF AMERICA,

DEPARTMENT OF THE INTERIOR,

UNITED STATES PATENT OFFICE.

To all to whom these presents shall come, Greeting:

THIS IS TO CERTIFY that the annexed is a true copy from the Records of this office of the File Wrapper and Contents, in the matter of the Letters Patent of Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard, and John Ballot, Number 835,120, Granted November 6, 1906, for Improvement in Ore Concentration.

IN TESTIMONY WHEREOF I have hereunto set my hand and caused the seal of the Patent Office to be affixed at the City of Washington, this [SEAL.] 5th. day of December, in the year of our Lord one thousand nine hundred and eleven and of the Independence of the United State of America the one hundred and thirty-sixth.

F A TENANT

Assistant Commissioner of Patents.

Defendant's Exhibit.

2—437.

Number (Series of 1900). 1905 Div'n. XXV.
262,889 Div. 25
Patent No. 835,120 (Ex'r's Book). 4—13
Name Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot
of London
County of
England
Invention Ore Concentrators

Division of App., No. , filed 190

Parts of application filed.

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	For Commissioner.	For Commissioner.
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Patented November 6, 1906
Associate Attorney Attorney Knight Bros.
McGill Buildg
Name Serial Number City
3 Patent No. Date of Patent

Defendant's Exhibit.

JOINT.
\$15— Received
May 29 1905 J
Chief Clerk U. S. Patent Office.

APPLICATION.
Serial No. 262,889 Paper No.

PETITION.

TO THE COMMISSIONER OF PATENTS.

Your Petitioners HENRY LIVINGSTONE SULMAN, HUGH FITZALIS and KIRKPATRICK-PICARD and JOHN BALLOT, subjects of the King of England, and residents of London England, whose Post Office addresses are respectively 44, London Wall, London, E. C., 44, London Wall, London, E. C., and 62, London Wall, London, E. C. pray that Letters Patent may be granted to them, as joint inventors, for the improvements in "ORE CONCENTRATION." set forth in the annexed Specification, and they hereby appoints Messrs Knight Bros McGill Bldg Washington D. C. a firm consisting of Hervey S Knight and Harry A Knight their Attorneys with full power of substitution and revocation, to prosecute this application, to make alterations and amendments therein to receive the Patent, and to transact all business in the Patent Office connected therewith.

Signed at London England this 17th day of May 1905

INVENTORS HENRY LIVINGSTONE SULMAN
HUGH FITZALIS KIRKPATRICK-PICARD
JOHN BALLOT

Defendant's Exhibit.

To all whom it may concern:—

Be it known that we, Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot, all subjects of the King of England, and residing in London, England, have invented certain new and useful improvements in Ore Concentration of which the following is a specification:—

This invention relates to improvements in the concentration of ores, the object being to separate metalliferous matter, graphite and the like from gagnue, by means of oils, fatty acids or other substances which have a preferential affinity for metalliferous matter over gangue.

In the process described in the previous United States Patent No. 777,273, granted to A. E. Cattermole, an amount of oil varying from 4% to 6% of the weight of metalliferous matter present is agitated with an ore pulp so as to form granules which can be separated from the gangue. In the previous United States Patent No. 777,274, granted to A. E. Cattermole and others, a similar method of separation is employed, oleic acid being produced *in situ* in the ore pulp.

We have found that if the proportion of oily substance be considerably reduced, say to a fraction of 1% on the ore, granulation ceases to take place and after vigorous agitation, there is a tendency for a part of the oil-coated metalliferous matter to rise to the surface ~~of the surface~~ of the pulp in the form of a froth or scum.

This tendency is dependent on a number of factors. Thus, the water in which the oiling is effected is prefer-

Defendant's Exhibit.

ably slightly acidified by adding say a fraction of 1% up to 1%, of sulphuric acid or other mineral acid or acid salt, the effect of this acidity being to prevent gangue from being coated with oily substance, or in other words, to render the selective action of the oil more marked; but it is to be understood that the object of using acid in the pulp according to this invention is not to bring about the generation of gas for the purpose of flotation thereby, and the proportion of acid used is insufficient to cause chemical action on the metalliferous minerals present.

Again, we have discovered that the tendency for the oily substance to disseminate through the pulp and the rapidity with which the metalliferous matter becomes coated is increased if the pulp is warmed.

The formation of froth is assisted by the fine pulverisation of the ore and we find that slime mineral most readily generates scum and rises to the surface while larger particles have less tendency to be included in the froth.

The proportion of mineral which floats in the form of froth varies considerably with different ores and with different oily substances, and before utilising the facts above mentioned in the concentration of any particular ore a simple preliminary test is necessary to determine which oily substance yields the proportion of froth or scum desired.

The following is an example of the application of this invention to the concentration of a particular ore.

An ore containing ferruginous blende, galena, and

Defendant's Exhibit.

gangue consisting of quartz, rhodonite, and garnet, is finely powdered and mixed with water containing a fraction of 1% or up to 1% of a mineral acid or acid salt, conveniently sulphuric acid, or mine or other waters containing ferric sulphate. To this is added a very small proportion of oleic acid (say, from 0.02% to 0.5% on the weight of ore), the mixture is warmed say to 30° to 40° C. and is briskly agitated in a cone mixer or the like, as in the processes previously cited, for about 2½ to 10 minutes, until the oleic acid has been brought into efficient contact with all the mineral particles in the pulp.

When agitation is stopped a large proportion of the mineral present rises to the surface in the form of a froth or scum which has derived its power of flotation mainly from the inclusion of air bubbles introduced into the mass by the agitation, such bubbles or air films adhering only to the mineral particles which are coated with oleic acid. The minimum amount of oleic acid which can be used to effect the flotation of the mineral in the form of froth may be under 0.1% of the ore, but this proportion has been found suitable and economical.

If the ore were crushed to 90 mesh to the linear inch (half of which ore will pass through 150 mesh sieve) the froth may contain about 70% to 80% of the metalliferous matter present in the ore. This froth is removed from the pulp by spitzkast, upcast, skimming, draining, or otherwise; after subsidence the oil-coated metalliferous matter removed as froth is separated

from any liquid which may have accompanied it and treated with a dilute solution of caustic alkali which removes the oleic acid in the form of a solution of soap.

If desired, the oleic acid used in the first instance may be produced *in situ* in the pulp by decomposing a dilute soap solution with mineral acid as described in the previous Patent No. 777274, cited above. The oleic acid or other fatty acid forming the coating on the metalliferous matter which produces the froth, may give rise to insoluble soaps on the surface of the metalliferous matter if soluble lime, iron or other salts are present in small quantity during the production, or on the breaking down of the froth with alkali; such insoluble soaps are difficult to remove and are capable of adhering to air and causing flotation much the same as the fatty acids do.

The metalliferous matter which did not form part of the froth (generally the larger particles) remains in admixture with the gangue in the pulp. To recover this, the pulp is distributed in a thin layer on a shaking table, convex buddle or the like, whereon the mineral is exposed to a free air surface, which exposure may be increased by the application of air blast or air jets or the like, and thereafter brought on to the edge or surface of liquid whereby the metalliferous matter floats and is separated from the gangue which sinks as described in the Specification of our previous United
Nov. 20/05 States Application No. 246,637, filed February 20, 1905.

The proportion of mineral recovered in the froth and that recovered by table flotation may be consider-

Defendant's Exhibit.

ably varied but generally speaking the froth will separate the slime mineral while the larger particles are recovered by the latter method.

Sub. A
. 17/06

The accompanying drawing is a diagram of one form of apparatue suitable for carrying this invention into practice.

" " Referring to Fig 1 a mixing

A mixing vessel A (of which there may be any number in series) is provided with a rotatable stirrer B. Crushed ore is fed from a hopper C into the vessel by a band D. A pipe E controlled by a tap E^1 delivers circuit water to the vessel, and oleic acid or other oil is introduced through pipe F and tap F^1. The other cock G from the vessel A communicates through a swan-neck pipe H with the froth separating apparatus.

P. 1981, L. 17, should read " spitzkasten (say between O and K) the pulp may if de- "

P. 1981, L. 18, should read " sited be run in a thin layer over a smooth slightly in- "

17/06
nceled

as illustrated in our previous application above referred to.

The froth separating apparatus comprises several (say three) pointed boxes J^1, J^2, J^3 which open at the top into a horizontal channel consisting of side walls K. The channel has a narrow inlet K^1 and spreads out to a wide outlet K^2. The pointed boxes J^1, J^2, J^3 havé full-way cocks L^1, L^2, L^3, at the bottom leading to swan-neck discharge pipes M^1, M^2, M^3. An up-current of

from any liquid which may have accompanied it and treated with a dilute solution of caustic alkali which removes the oleic acid in the form of a solution of soap.

If desired, the oleic acid used in the first instance may be produced *in situ* in the pulp by decomposing a dilute soap solution with mineral acid as described in the previous Patent No. 777274, cited above. The oleic acid or other fatty acid forming the coating on the metalliferous matter which produces the froth, may give rise to insoluble soaps on the surface of the metalliferous matter if soluble lime, iron or other salts are present in small quantity during the production, or on the breaking down of the froth with alkali; such insoluble soaps are difficult to remove and are capable [illegible] flotation much the same

[illegible]

the froth (generally the larger particles) remains [illegible]

[illegible]

[illegible] the like, whereon the mineral is exposed to a free air surface, which exposure may be increased by the application of air blast or air jets or the like, and thereafter brought on to the edge or surface of liquid whereby the metalliferous matter floats and is separated from the gangue which sinks as described in the Specification of our previous United

Nov. 20/05 States Application No. 246,637, filed February 20, 1905.

The proportion of mineral recovered in the froth and that recovered by table flotation may be consider-

Defendant's Exhibit.

ably varied but generally speaking the froth will separate the slime mineral while the larger particles are recovered by the latter method.

Sub. A
. 17/06 ~~The accompanying drawing is a diagram of one form of apparatue suitable for carrying this invention into practice.~~

" " Referring to Fig 1 a mixing

A mixing vessel A (of which there may be any number in series) is provided with a rotatable stirrer B. Crushed ore is fed from a hopper C into the vessel by a band D. A pipe E controlled by a tap E^1 delivers circuit water to the vessel, and oleic acid or other oil is introduced through pipe F and tap F^1. The other cock G from the vessel A communicates through a swan-neck pipe H with the froth separating apparatus.

In passing from the frothing apparatus A to the sired be run in a thin layer over a smooth slightly in-spitzkasten (say between O and K) the pulp may if de-

nceled 24/06 clined plane ~~and may be submitted to the action of a~~
20/05 ~~series of air jets in order to increase the amount of~~
nceled
17/06 ~~floating metalliferous matter to a maximum.~~
nceled as illustrated in our previous application above referred to.

The froth separating apparatus comprises several (say three) pointed boxes J^1, J^2, J^3 which open at the top into a horizontal channel consisting of side walls K. The channel has a narrow inlet K^1 and spreads out to a wide outlet K^2. The pointed boxes J^1, J^2, J^3 have full-way cocks L^1, L^2, L^3, at the bottom leading to swan-neck discharge pipes M^1, M^2, M^3. An up-current of

water may be led in at the bottom of each through a tap N^1, N^2, N^3.

The boxes are all filled with circuit water; the pulp from the vessel A is distributed horizontally from the flat trough O through the inlet K^1. The heavy sands and coarser particles of mineral sink into the first box J^1 from which they are led to a shaking table, convex buddle, or the like to be treated as above described. The middlings or medium sands fall into the box J^2 and if they contain any mineral, may be removed for further treatment by agitation. The up-current of water from the taps N^1 N^2 prevents the deposition of any slime in these boxes. The fine sands or gangue slimes settle in the last box J^3 from which they are discharged to waste or further treatment.

The slime mineral in the form of froth or scum floats from the liquid and is carried by the stream over the outlet K^2 into a launder P and thence to a filter Q where the metalliferous matter is removed from the circuit water which is returned to the vessel A by a pump R. The circuit water may be brought to the proper temperature by passing it through a heater S having a burner S^1 before admitting the water to the vessel A.

An alternative method for the recovery of any sunk oiled metalliferous matter which may be deposited in the second and third spitzkasten is as follows: — The products suspended in circuit liquor are removed from the spitzkasten and placed in a vessel in which they are submitted to an additional pressure of air or other gas

Defendant's Exhibit.

of from, say, 1 to 2 atmospheres, or over. On relief of such pressure the bubbles of air, or other gas so generated throughout the mass at once sweep to the surface thereof all the metalliferous matter in the form of a froth which can be separated as before.

sert A[1] . 17/06 sert A[2] . 17/06

The nature and arrangement of the apparatus used may be varied without departing from this invention.

What we claim as our invention and desire to secure by Letters Patent is: —

1. The herein described process of concentrating ores which consists in mixing the powdered ore with water, adding a small proportion of an oily liquid having a preferential affinity for metalliferous matter, (amounting to a fraction of 1% on the ore), agitating the mixture until the oil-coated mineral matter forms into a froth, and separating the froth from the remainder by flotation.

2. The herein described process of concentrating ores which consists in mixing the powdered ore with slightly acidified water, adding a small proportion of an oily liquid having a preferential affinity for metalliferous matter (amounting to a fraction of 1% on the ore), agitating the mixture until the oil-coated mineral matter forms into a froth and separating the froth from the remainder by flotation.

3. The herein described process of concentrating ores which consists in mixing the powdered ore with slightly acidified water, adding a small proportion of an oily liquid having a preferential affinity for metalliferous matter (amounting to a fraction of 1% on the

ore), warming the mixture, agitating the mixture until the oil-coated mineral matter forms into a froth and separating the froth from the remainder by flotation.

4. The herein described process of concentrating ores which consists in finely powdering the ore, mixing it with slightly acidified water, adding a small proportion of an oily substance having a preferential affinity for metalliferous matter (amounting to a fraction of 1% on the ore), warming the mixture, agitating the mixture until the oil-coated mineral matter forms into a froth, separating the froth from the remainder by flotation, and removing the oily coating from the mineral.

5. The herein described process of concentrating ores which consists in mixing the powdered ore with water, adding a small proportion of oleic acid amounting to 0.02 -- 0.5% on the ore, agitating the mixture until the oleic acid has been brought into efficient contact with the mineral and has formed a froth therewith, and separating the froth from the remainder by flotation.

6. The herein described process of concentrating ores which consists in mixing the powdered ore with

Apr. 17/06 water containing a fraction of less than 1% of sulphuric acid, adding a small proportion of oleic acid amounting to 0.02 -- 0.5% on the ore, agitating the mixture until the oleic acid has been brought into efficient contact with the mineral and has formed a froth therewith, and separating the froth from the remainder by flotation.

7. The herein described process of concentrating ores which consists in mixing the powdered ore with

Defendant's Exhibit.

r. 17/06

water containing a fraction of ~~less than~~ 1% of sulphuric acid, adding a small proportion of oleic acid amounting to 0.02 -- 0.5% on the ore, warming the mixture to 30° -- 40° C., agitating the mixture until the oleic acid has been brought into efficient contact with the mineral and has formed a froth therewith, and separating the froth from the remainder by flotation.

8. The herein described process of concentrating ores which consists in finely powdering the ore, mixing it with water containing a fraction of ~~less than~~ 1% of sulphuric acid, adding sufficient oleic soap solution to produce oleic acid amounting to 0.02 -- 0.5% on the ore, warming the mixture to 30° -- 40° C., agitating the mixture until the oleic acid has been brought into efficient contact with the mineral and has formed a froth therewith, separating the froth from the remainder by flotation, filtering off the froth and removing the oleic acid therefrom by treatment with an alkali.

t A² 17/06

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iceled 17/06

9. The herein described process of concentrating ores which consists in finely powdering the ore, mixing it with water containing less than 1% of sulphuric acid, adding sufficient oleic soap solution to produce oleic acid amounting to 0.02 -- 0.5% on the ore, warming the mixture to 30° -- 40° C., agitating the mixture until the oleic acid has been brought into efficient contact with the mineral and has formed a froth with the finer mineral, distributing the mixture on the surface of a current of water running over columns of water, so that the coarser minerals and sands, the finer sands

Defendant's Exhibit.

~~and~~ the gangue slimes successively deposit out while the froth ~~is~~ floated away by the current, filtering off the froth and removing the oleic acid therefrom by treatment with an alkali ~~and~~ separating the coarser mineral from the sands by exposing ~~them~~ alternately
Nov. 20/05 to air and water ~~on a shaking table.~~

In testimony whereof we have signed our names to this Specification in the presence of two subscribing witnesses.

Henry Livingstone Sulman
Hugh Fitzalis Kirkpatrick-Picard
John Ballot

Two Witnesses.

Geo J B Franklin
T. J. Osman

Defendant's Exhibit.

OATH.

Oath filed 17/06

LONDON
ENGLAND } SS.

HENRY LIVINGSTONE SULMAN, HUGH FITZALIS KIRKPATRICK-PICARD and JOHN BALLOT, the above named petitioners, being duly sworn, depose and say that they are subjects of the King of England and residents of London in England, ; and that they verily believe themselves to be the original, first, and joint inventors of the improvements in "ORE CONCENTRATION." described and claimed in the annexed Specification; that they do not know and do not believe that the same was ever known or used before their invention or discovery thereof; or patented or described in any printed publication in any country before their invention or discovery thereof, or more than two years prior to this application; or patented in any country foreign to the United States on an application filed more than twelve months before this application; or in public use or on sale in the United States for more than two years prior to this application; and that no application for patent on said improvements has been filed by them or their representatives or assigns in any country foreign to the United States, except as follows: Great Britain No. 7803, dated 12th April 1905, and Australia.

HENRY LIVINGSTONE SULMAN
HUGH FITZALIS KIRKPATRICK-PICARD
JOHN BALLOT

Sworn to and subscribed before me this 17 day of May, 1905 by all three Deponents

(Notarial Seal) G. F. WARREN,
[Revenue Stamp.] Notary Public

Defendant's Exhibit.

CONSULATE-GENERAL OF THE UNITED STATES OF AMERICA FOR GREAT BRITAIN & IRELAND AT LONDON.

I, Richard Westacott, Vice and Deputy Consul-General of the United States of America at London, England do hereby make known and certify to all whom it may concern that George Frederick Warren, who hath signed the annexed Certificate, is a Notary Public, duly admitted and sworn and practising in the city of London, aforesaid, and that to all acts by him so done full faith and credit are and ought to be given in Judicature and thereout.

In Testimony Whereof, I have hereunto set my hand and affixed my Seal of Office at London aforesaid, this Nineteenth day of May in the year of our Lord One Thousand Nine Hundred and five.

(Consular Seal) Vice and Deputy Consul-General.

Defendant's Exhibit.

2—260

Div. 25 Room 315 Paper No. 1

Address only "The Commissioner of Patents, Washington, D. C."

All communications respecting this application should give the serial number, date of filing, and title of invention.

M. E. C. DEPARTMENT OF THE INTERIOR

UNITED STATES PATENT OFFICE

WASHINGTON, D. C., August 9, 1905.
Mailed " " "

SULMAN, KIRKPATRICK-PICARD AND BALLOT,
Care Knight Bros.,
City.

Please find below a communication from the EXAMINER in charge of your application. # 262,889, filed May 29, 1905, for Ore Concentration.

F. I. ALLEN
Commissioner of Patents.

Date is required as to the Australian application referred to in the oath; such data should be supported by affidavit. The filing date of the application referred to in line 6, page 5 should be inserted. The jetting means (last two lines, page 5) are required to be illustrated, as is also the apparatus for the alternative procedure described in the second paragraph of page 7, as well as

the shaking table form recited in claim 9. The particular apparatus should not be made an essential of a process claim such as the 9th.

LEWIS B. WYNNE
Examiner,
Division XXV.

T. F. MITCHELL

Patent Office
Nov 20 1905
Division XXV.

Serial No. 262,889 Paper No. 2

AMENDMENT.

Inventors Sulman, Picard and Ballot.
Invention: Ore Concentration.
Filed May 29, 1905 Serial No. 262,889

HON. COMMISSIONER OF PATENTS,

Sir:

The above named application is hereby amended as follows:

The Australian application was not filed at the time of filing of this application.

Page 5, to the end of line 6, add "filed February 20, 1905"

Page 6, to the end of line 1, add

—as illustrated in our previous application above referred to—. It is thought that the requirement as to the showing of the jetting means should be waived in view of this amendment.

Defendant's Exhibit.

An additional drawing will be filed showing the alternative procedure described on page 7.

Claim 9, lines 17 and 18, cancel "on a shaking table"

Respectfully submitted,

WASHINGTON, D. C., KNIGHT BROS.
P. November 18, 1905. Attorneys.

2—260

Div. 25 Room 315 Paper No. 3

Address only "The Commissioner of Patents, Washington, D. C."

All communications respecting this application should give the serial number, date of filing, and title of invention.

M. E. C. DEPARTMENT OF THE INTERIOR

UNITED STATES PATENT OFFICE

WASHINGTON, D. C., November 23, 1905.
MAILED. " " "

SULMAN, KIRKPATRICK-PICARD AND BALLOT,
Care Knight Bros.,
City.

Please find below a communication from the EXAMINER in charge of your application. # 262,889, filed May 29, 1905, for Ore Concentration.

F. I. ALLEN
Commissioner of Patents.

Case as amended November 20, 1905, further considered.

the shaking table form recited in claim 9. The particular apparatus should not be made an essential of a process claim such as the 9th.

Lewis B. Wynne
Examiner,
Division XXV.

T. F. Mitchell

Patent Office
Nov 20 1905
Division XXV.

Serial No. 262,889 Paper No. 2

Amendment.

Inventors Sulman, Picard and Ballot.
Invention: Ore Concentration.
Filed May 29, 1905 Serial No. 262,889

Hon. Commissioner of Patents,

Sir:

The above named application is hereby amended as follows:

The Australian application was not filed at the time of filing of this application.

Page 5, to the end of line 6, add "filed February 20, 1905"

Page 6, to the end of line 1, add

—as illustrated in our previous application above referred to—. It is thought that the requirement as to the showing of the jetting means should be waived in view of this amendment.

Defendant's Exhibit.

An additional drawing will be filed showing the alternative procedure described on page 7.

Claim 9, lines 17 and 18, cancel "on a shaking table"

Respectfully submitted,

WASHINGTON, D. C., KNIGHT BROS.

P. November 18, 1905. Attorneys.

2—260

Div. 25 Room 315 Paper No. 3

Address only "The Commissioner of Patents, Washington, D. C."

All communications respecting this application should give the serial number, date of filing, and title of invention.

M. E. C. DEPARTMENT OF THE INTERIOR

UNITED STATES PATENT OFFICE

WASHINGTON, D. C., November 23, 1905.

MAILED. " " "

SULMAN, KIRKPATRICK-PICARD AND BALLOT,

Care Knight Bros.,

City.

Please find below a communication from the EXAMINER in charge of your application. # 262,889, filed May 29, 1905, for Ore Concentration.

F. I. ALLEN

Commissioner of Patents.

Case as amended November 20, 1905, further considered.

Defendant's Exhibit.

The amendment inserted at the end of line 1, page 6, is nothing more than a reference to another application for details which should appear in this case. Such reference is not permissible. Illustration of the jetting means will therefore be insisted upon. It is required that the expression "water containing less than 1 per cent of sulphuric acid" be replaced by one more definite in such claims as contain the expression. It may mean water without a trace of sulphuric acid. It is suggested that "water containing a fraction of 1 per cent of sulphuric acid" be substituted.

The drawing should be filed at once. A complete response to an action dealing with formal matters must include response to every item.

LEWIS B. WYNNE
Examiner, Division XXV.

T. F. Mitchell

Defendant's Exhibit.

Amend't and Oath
Serial No. 262,889 Paper No. 4

Application Room
Apr 17 1906
U. S. Patent Office.
Room No. 315.

Patent Office
Apr 18 1906
Division XXV.

AMENDMENT.

Inventor: Sulman, Kirkpatrick-Picard & Ballot
Invention: Ore concentration.
Filed May 29, 1905. Ser. No. 262889.

HON. COMMISSIONER OF PATENTS,

Sir:—

The above-named application is hereby amended as follows:—

A new oath is filed herewith.

The Examiner will kindly place "Fig. 1" on the original sheet.

Add the sheet of drawing filed herewith.

Referring to the original specification, on page 5, cancel lines 13, 14 and 15 and insert the following:

"In the accompanying drawings,

A. "Figure 1 is a diagram in perspective illustrating one form of apparatus suitable for carrying this invention into practice, and,

"Figure 2 represents is perspective an apparatus for carrying out a secondary step in the process."

Defendant's Exhibit.

Page 5, line 16, change "A mixing" to *Referring to Fig.* 1 *a mixing*

Page 7, line 19, after "before" insert *This idea is*

A[1] not claimed broadly in this case but forms the subject matter of an application filed by us on January 9, 1906, Ser. No. 295,326.

On page 7 of the original specification, three lines from the bottom, add:

A[2] Referring to Fig. 2, a mixing vessel a (of which there may be several) in series) is provided with a rotatable stirrer b. Crushed ore or similar finely divided mineral is fed into the vessel a. A pipe c controlled by a tap c' delivers circuit water to the vessel and in cases where oil is used, the oil is introduced through the pipe d in quantity sufficient to produce a thin coating of oil on these mineral particles for which oil has an affinity.

The pulp mixed with oil escapes over the lip of the discharge conduit a^1 and passes through the pipe a^2 to a pump e. Hence the pulp is pumped through discharge pipe c' into the closed chamber f which is constructed to withstand a considerable internal pressure and is provided with a safety valve f', the pressure gauge f^2, and a gauge glass f^3 to indicate the level of the pulp in the chamber. An outlet pipe g having a cock g' leads to a series of spitzkasten h filled with circuit water.

The operation is as follows:

The cock g' is closed; pulp is pumped into the cham-

Defendant's Exhibit.

ber *f* which contains air or other gas and the pumping is continued until the pressure in the chamber rises to, say, 50 to 100 lbs. per square inch. The pressure is sufficient to cause the air or other gas to be dissolved to a considerable extent in the pulp. After the lapse of a few minutes for the due solution of the compressed air or a portion of it by the pulp or the liquid, the cock *g* is opened and the pulp is discharged into the open spitzkasten *h* where the liquid is of course under atmospheric pressure. The pump *e* may be

r. 24/06 stopped during ~~furing~~ this discharge.

The whole of the mineral to which air bubbles are attached, say the oiled, mineral, at once rises to the surface as a coherent scum or froth. A surface current of water is maintained in the spitzkasten and the floating material is thus removed and separated from the gangue which remains sunk or suspended in the liquid. "

ot entd orrected r. 24/06 + Page 5, cancel from and including "may" line 3, to and including "maximum" page 6, line 1.

Also cancel the insert at the end of line 1, page 6.

Claims 6, 7 and 8, line 3, change "less than" to *a fraction of*

Cancel claim 9.

Insert the following claims:

A3 9. The process of concentrating powdered ores which consists in separating the mineral from the gangue by coating the mineral with oil in water containing a small quantity of oil, agitating the mixture to form a froth, and separating the froth.

Defendant's Exhibit.

10. The process of concentrating powdered ores which consists in separating the mineral from the gangue by coating the mineral with oil in water containing a small quantity of oil, warming the mixture, agitating the mixture to form a froth, and separating the froth.

11. The process of concentrating powdered ores, which consists in separating the mineral from the gangue by coating the mineral with oil in water containing a small quantity of oil, and a quantity of acid insufficient to cause chemical action on the metalliferous minerals present, agitating the mixture to form a froth, and separating the froth.

Canceled June 29/06

~~12. The process of concentrating powdered ore which consists in separating the minerals from gangue by coating the minerals with oil in water containing a fraction of 1% of oil on the ore, and recovering the oil coated minerals.~~

12 ~~12.~~ The process of concentrating powdered ore which consists in separating the minerals from gangue by coating the minerals with oil in water containing a fraction of 1% of oil on the ore, agitating the mixture to cause the oil coated mineral to form a froth, and separating the froth from the remainder of the mixture.

Canceled June 15/06

~~14. The herein described process of concentrating ores which consists in mixing powdered ores with water, adding a small proportion of oily liquid having a preferential affinity for metalliferous matter, (amounting to a fraction of 1% on the ore) agitating~~

Defendant's Exhibit.

the mixture until part of the oil-coated mineral matter forms into a froth, removing the froth, subjecting the remaining pulp to the action of a compressed gas in a closed chamber, and thereafter relieving the pressure whereby gaseous bubbles are liberated in the pulp and raise the oil-coated mineral particles to the surface.

sert B
24/06

Respectfully submitted,

KNIGHT BROS
Attorneys.

WASH. D. C.
April 14, 1906.
T. .

Kingdom of Great Britain and Ireland }
City of London, England. } ss:

HENRY LIVINGSTONE SULMAN, HUGH FITZALIS KIRKPATRICK-PICARD, & JOHN BALLOT, being sworn, depose and say that they are subjects of the King of England, and residents of London, England, that they verily believe themselves to be the original, first and joint inventors of the improvement in Ore Concentration described and claimed in the application filed May 29, 1905, Ser. No: 262889," that they do not know and do not believe that the same was ever known or used before their invention or discovery thereof, or patented or described in any printed publication in any country before their invention or discovery, or more than two years prior to this application, or patented in any country foreign to the United States on an application filed more than twelve months before this

Defendant's Exhibit.

application, or in public use or on sale in the United States for more than two years prior to this application; and that no application for patent on said improvement has been filed by them or their representatives or assigns in any country foreign to the United States, except as follows:—

Great Britain, April 12th, 1905, under No: 7803.

HENRY LIVINGSTONE SULMAN
HUGH FITZALIS KIRKPATRICK-PICARD
JOHN BALLOT

Sworn to and subscribed before me this 3rd day of January, 1906

(Consular Seal) RICHARD WESTACOTT

Vice and Deputy Consul-General of the United States of America at London, England.

Defendant's Exhibit.

2-260

Div. 25 Room 315 Paper No 5

Address only "The Commissioner of Patents, Washington, D. C."

All communications respecting this application should give the serial number, date of filing, and title of invention.

M. E. C.

DEPARTMENT OF THE INTERIOR

UNITED STATES PATENT OFFICE

WASHINGTON, D. C., April 20, 1906.

MAILED. " " "

SULMAN, KIRKPATRICK-PICARD AND BALLOT,
Care Knight Bros.,
City.

Please find below a communication from the EXAMINER in charge of your application. #262,889, filed May 29, 1905, for Ore Concentration.

F. I. ALLEN
Commissioner of Patents.

Case amended April 17, 1906, further considered.

"Furing," last line, page 2 of the amendatory paper should be corrected. The data as to the cancellation directed on page 5 are incorrect; said amendment cannot be made until corrected data are furnished.

Defendant's Exhibit.

In presenting claim 14, applicants make a change of election in shifting from the shaking-table step of original claim 9 to the air compression and flotation step. This change is made after the case has been twice acted on by the office, and is too late. Said claim 14 is required to be canceled. Applicants may, if they so desire, restore original claim 9.

LEWIS B. WYNNE
Examiner, Div. XXV.

T. F. Mitchell

Application Room
Apr 24 1906
U. S. Patent Office.

Patent Office,
Apr 25 1906
Division XXV.

Room No. 315

Serial No. 262889 Paper No. 6

AMENDMENT

Inventors: Sulman, Picard & Ballot.
Invention: Ore Concentration.
Filed May 29, 1905. Serial No. 262,889.

HON. COMMISSIONER OF PATENTS,
Sir:

The above named application is hereby amended as follows:

In the amendment filed April 17th, page 2, last line, change "furing" to *during*

Page 5, cancel matter beginning "and may" line 29 and ending page 6, line 1, with "maximum"

Insert the following claims—

Defendant's Exhibit.

B

13– ~~14 15~~. The herein described process of concentrating ores which consists in finely powdering the ore, mixing it with water containing less than 1% of sulphuric acid, adding sufficient oleic soap solution to produce oleic acid amounting to 0.02–0.5% on the ore, warming the mixture to 30°–40°C., agitating the mixture until the oleic acid has been brought into efficient contact with the mineral, and has formed a froth with the finer mineral, distributing the mixture on the surface of a current of water running over columns of water, so that the coarser minerals and sands, the finer sands and the gangue slimes successively deposit out while the froth is floated away by the current, filtering off the froth and removing the oleic acid therefrom by treatment with an alkali and separating the coarser mineral from the sands by exposing them alternately to air and water.

We think the Examiner will upon reconsideration not hold that claims 14 and 15 are alternative.

Beginning page 6, line 15, applicant states that the material of the first spitzkasten is treated on the shaking table, while in lines 12 et seq, page 7, he states that the material of the second and third spitzkasten is treated by the process set forth in claim 14. It will thus be seen that the two steps may be employed together and, therefore, are not alternative.

Respectfully submitted,

KNIGHT BROS

Attorneys.

WASHINGTON, D. C.,

April 23, 1906.

P.

Defendant's Exhibit.

2–260

Div. 25 Room 315 Paper No. 7

Address only "The Commissioner of Patents, Washington, D. C."

All communications respecting this application should give the serial number, date of filing and title of invention.

M. E. C.

DEPARTMENT OF THE INTERIOR

UNITED STATES PATENT OFFICE

WASHINGTON, D. C., April 26, 1906.
MAILED. " " "

SULMAN, KIRKPATRICK-PICARD AND BALLOT,
Care Knight Bros.,
Cityz

Please find below a communication from the EXAMINER in charge of your application. #262,889, filed May 29, 1905, for Ore Concentration.

F. I. ALLEN
Commissioner of Patents.

Case as amended April 24, 1906, further considered.

Applicants are again and finally required to cancel claim 14. Applicants specifically state that the method thereof is alternative with that covered by claim 15, and the fact that one may be substituted for the other for the treatment of part does not make them any

Defendant's Exhibit.

the less alternative and independent processes. The next step must be either compliance with this requirement or appeal to the Board of Examiners-in-Chief.

LEWIS B. WYNNE
Examiner,
Div. XXV.

T. F. Mitchell

Application Room
June 15 1906
U. S. Patent Office.
Room No. 315.

Patent Office
June 16 1906
Division XXV.
Serial No. 262,889 Paper No. 8

AMENDMENT

Inventors: Sulman, Kirkpatrick-Picard & Ballot,
Invention: Ore Concentration.
Filed May 29, 1905. Ser. No. 262,889.

HON. COMMISSIONER OF PATENTS,

Sir:—

The above-named application is hereby amended as follows—

Cancel claim 14 and adjust the numerals of the remaining claims.

Respectfully submitted,
KNIGHT BROS
Attorneys.

WASH. D. C.
June 15, 1906.

Defendant's Exhibit.

2–260

Div. 25 Room 315 Paper No. 9

Address only "The Commissioner of Patents, Washington, D. C."

All communications respecting this application should give the serial number, date of filing, and title of invention.

M. E. C.

DEPARTMENT OF THE INTERIOR

UNITED STATES PATENT OFFICE

WASHINGTON, D. C., June 18, 1906.

MAILED. " " "

SULMAN, KIRKPATRICK-PICARD AND BALLOT,

Care Knight Bros.,

City.

Please find below a communication from the EXAMINER in charge of your application. #262,889, filed May 29, 1905, for Ore Concentration.

F. I. ALLEN

Commissioner of Patents.

Case as amended Jaune 15, 1906, further considered.

Claim 12 is rejected in view of 763,260, Cattermole, June 21, 1904; or 793,808, Sulman et al., July 4, 1905, Washers (H), as expressing merely a difference of degree thereover as to the proportion of oily matter employed.

LEWIS B. WYNNE

Examiner,

Div. XXV.

T. F. Mitchell

Defendant's Exhibit.

Application Room
June 29 1906
U. S. Patent Office

Patent Office,
Jun 30 1906
Division XXV.

Serial No. 262889 Paper No. 10

Room No. 315

AMENDMENT.

Inventors: Sulman, Picard & Ballot.
Invention: Ore Concentration.
Filed May 29, 1905. Serial No. 262,889.

HON. COMMISSIONER OF PATENTS.

Sir:

The above named application is hereby amended as follows:

Cancel claim 12 and adjust the numerals of the remaining claims.

Respectfully submitted,
KNIGHT BROS
Attorneys.

WASHINGTON, D. C., June 28, 1906.

P.

Defendant's Exhibit.

A. R.
Issue Division. Serial No. 262,889

All communications should be addressed to "The Commissioner of Patents, Washington, D. C."

DEPARTMENT OF THE INTERIOR,

UNITED STATES PATENT OFFICE,

WASHINGTON, D. C., July 6, 1906

HENRY L. SULMAN, HUGH F. KIRKPATRICK-PICARD AND JOHN BALLOT,
%Knight Bros,
City.

Sir:

Your APPLICATION for a patent for an IMPROVEMENT IN ORE CONCENTRATION, filed May 29, 1905, has been examined and ALLOWED.

The final fee, Twenty Dollars, must be paid, and the Letters Patent bear date as of a date not later than SIX MONTHS from the time of this present notice of allowance.

If the final fee is not paid within that period the patent will be withheld, and your only relief will be by a renewal of the appplication, with additional fees, under the provisions of Section 4897, Revised Statutes. The office aims to deliver patents upon the day of their date, and on which their term begins to run; but to do this properly applicants will be expected to pay their final fees at least TWENTY DAYS prior to the conclusion of the SIX months allowed them by law. The printing,

Defendant's Exhibit.

photolithographing, and engrossing of the several patent parts, preparatory to final signing and sealing, will consume the intervening time, and such work will not be done until after payment of the necessary fees.

When you send the final fee you will also send, DISTINCTLY AND PLAINLY WRITTEN, the name of the INVENTOR and TITLE OF INVENTION AS ABOVE GIVEN, DATE OF ALLOWANCE (which is the date of this circular), DATE OF FILING, and, if assigned, the NAMES OF THE ASSIGNEES.

If you desire to have the patent issue to ASSIGNEES, an assignment containing a REQUEST to that effect, together with the FEE for recording the same, must be filed in this office on or before the date of payment of final fee.

After issue of the patent uncertified copies of the drawings and specifications may be purchased at the price of FIVE CENTS EACH. The money should accompany the order. Postage stamps will not be received.

Respectfully,

F. I. ALLEN,

Commissioner of Patents.

In remitting the final fee give the serial number at the head of this notice.

Uncertified checks will not be accepted.

Defendant's Exhibit.

2—327.

$20.^{00} Received
Oct 16 1906 H
Chief Clerk, U. S. Patent Office.

MEMORANDUM OF FEE PAID AT UNITED STATES PATENT OFFICE.

(Be careful to give correct Serial No.)

Serial No. 262889 , 19 0

Inventor: H. L. Sulman, H. T. Kirkpatrick Picard & J. Ballot

Patent to be issued to

Name of invention, as allowed: Ore Concentration

Date of payment: Oct 16 1906.

Fee: $20^{00}

Date of filing: May 29-05

Date of circular of allowance: July 6 06

The Commissioner of Patents will please apply the accompanying fee as indicated above.

KNIGHT BROS.
Attorney.

Send patents to Knight Bros
McGill Bldg
City

Defendant's Exhibit.

JMH 2—191. Serial No.262889

Address only "The Commissioner of Patents, Washington, D. C."

DEPARTMENT OF THE INTERIOR

UNITED STATES PATENT OFFICE

WASHINGTON, D. C., Oct. 18, 1906.

HENRY LIVINGSTONE SULMAN, HUGH FITZALIS KIRKPATRICK-PICARD AND JOHN BALLOT,
c/o Knight Bros.,
McGill Building,
Washington, D. C.

Sir:

You are informed that the final fee of TWENTY DOLLARS has been received in your application for Improvement in Ore Concentration.

Very respectfully

F. I. ALLEN.
Commissioner of Patents.

[Here follows printed copy of Patent 835,120.]

Defendant's Exhibit.

1905

83. MILLS,
Ore and Coal:
Washers.

CONTENTS:

Print
Application papers.
1. Letter Aug. 9, 1905
2. Amendment Nov. 20, 1905
3. Letter Nov. 23, 1905
and Oath
4. Amend't A Apr 17 1906.
5. Letter Apr-20, 1906.
6. Amendt B. Apr-24, 1906.
7. Letter Apr-26, 1906
8. Amendment June 15, 1906
9. Rej. June 18, 1906
10. Amendment June 29, 1906.
11.
12.
13.
14.
15.
16.
17.
18.
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21.
22.
23.

TITLE:

Improvement in Ore Concentration

Defendant's Exhibit.

Defendant's Exhibit Certified Copy of File-Wrapper and Contents of Kirby Patent No. 838,626.

UNITED STATES OF AMERICA,

DEPARTMENT OF THE INTERIOR,

UNITED STATES PATENT OFFICE.

To all to whom these presents shall come, Greeting:

THIS IS TO CERTIFY that the annexed is a true copy from the Records of this Office of the File Wrapper and Contents, in the matter of the Letters Patent of Edmund B. Kirby, Number 838,626, Granted December 18, 1906, for Improvement in Separating-Tanks.

IN TESTIMONY WHEREOF I have hereunto set my hand and caused the seal of the Patent Office to be affixed at the City of Washington, this 3rd day of June, in the year of [SEAL.] our Lord one thousand nine hundred and twelve and of the Independence of the United States of America the one hundred and thirty-sixth.

F A TENNANT
Acting Commissioner of Patents.

Defendant's Exhibit.

2–437.

Number (Series of 1900). 1903 Div 25

185,475 (Ex'r's Book). 43–115

Patent No. 838 626

Name Edmund B. Kirby,

of Rossland,

State of Canada

Invention Separating Tank,

, filed , 190

Parts of application filed.

	Original.	Renewed.
Petition	Dec. 17, 1903	, 190
Affidavit	" ", 1903	, 190
Specification	" ", 1903	, 190
Drawing 2 shts	" ", 1903	, 190
Model or Specimen Not req'd	, 190	, 190
First Fee Cash $\$15^{00}$	Dec. 17, 1903	, 190
1 " " Cert.	, 190	, 190
App filed complete	Dec 17, 1903	, 190

Division of App., No.

Examined Lewis B. Wynne, May 21st 1906		, 190
Countersigned R E Grant		, 190
	For Commissioner.	For Commissioner.
Notice of Allowance	May 24, 1906	, 190
Final Fee Cash	, 19	, 190
2 " " Cert. $20	Nov. 24, 1906	, 190
Patented		December 18, 1906
		Nov. 24, 1906,

Sub

Associate Attorney *Thurston,* Bates
and Woodward Attorney Thurston & Bates
1028 Soc. for Sav. Bldg.
Cleveland, Ohio.

3 Name Serial Number

Patent No. Date of Patent

Defendant's Exhibit.

$15–Received
Ck Dec 17 1903
Chief Clerk *L Z A*
U. S. Patent Office   Dec. 15, 1903.

COMMISSIONER OF PATENTS,
Washington, D. C.

Dear Sir:—

In the matter of the application about to be filed by Edmund B. Kirby, for Separating Tanks, executed December 4, 1903, we hand you herewith by mail the following:—

Petition and Power of Attorney,
Specification,
Oath,
Two Sheet of Drawings.

Government Fee: $15.00 enclosed in our check.

Yours truly,
THURSTON & BATES.

Mail Room   Serial No. 185.475   Paper No. ½
Dec 17 1903   Application.   1903
U. S. Patent Office.

TO THE COMMISSIONER OF PATENTS:

Your petitioner, Edmund B. Kirby, a citizen of the United States residing at Rossland, in the Province of British Columbia, and Dominion of Canada, whose Post Office address is Rossland, British Columbia, Canada, prays that Letters Patent may be granted to

Defendant's Exhibit.

him for the improvement in Separating Tanks, set forth in the annexed specification.

And he hereby appoints the firm of Thurston & Bates, (Reg. #1130), of Cleveland, Ohio, (said firm consisting of E. L. Thurston and Albert H. Bates) his attorneys, with full power of subtsitution and revocation, to prosecute this application, to make alterations and amendments therein, to sign the drawings, to receive the patent, and to transact all business in the Patent office connected therewith.

Signed at Northport, in the County of Stevens and State of Washington, this fourth day of Dec. 1903

Edmund B Kirby

Specification.

To all whom it may concern:

Be it known that I, Edmund B. Kirby, a citizen of the United States, residing at Rossland, in the Province of British Columbia and Dominion of Canada, have invented a certain new and useful improvement in Separating Tanks, of which the following is a full, clear and exact description, reference being had to the accompanying drawings.

The object of this invention is to effect with substantial completeness, the seggregation of those pulverized mineral particles which have a preferential adhesion for water from those which have a preferential adhesion for a liquid immiscible in water,—for example oil or a solution of bitumen in kerosene. This

Apr. 4/05

Defendant's Exhibit.

invention is for the treatment of the charge after the pulverized mineral, the oil or solution and the water have been thoroughly mixed together, whereby nearly all of the mineral particles which exhibit adhesive preference for the oil or solution have been coated therewith. The invention is most useful when used to carry on one step of a process of my own invention, wherein the immiscible liquid employed is thin and light, as for example, a solution of bitumen in kerosene. But the invention is also useful with oil processes for separating mineral particles. This invention, which relates to the separator tank and its cooperating adjuncts, may be here summarized as consisting in the construction and combinations of parts shown in the drawing and hereinafter described, as definitely set forth in the claims.

In the drawing figure 1 is an elevation partly in vertical section of an apparatus embodying my invention. Figure 2 is a plan view thereof; Figure 3 is a vertical sectional view of the agitator shaft and a part of one side of the tank; and figure 4 is a sectional plan view of the said shaft and one of the agitator arms secured thereto below the section line.

The tank A is preferably cylindrical. Into it is to be charged the materials to be separated, to wit, pulverized ore, water, and some liquid lighter than water and immiscible therein, which will adhere only to the metallic mineral part of the pulverized ore,—said materials having, preferably, been thoroughly mixed in another tank. The immiscible liquid may, as stated, be

oil, or a light hydrocarbon, or a solution of bitumen in a light hydrocarbon. The apparatus was especially designed for use with a charge consisting of ore, water and solution of bitumen in kerosene,—and therefore, the immiscible liquid will, for convenience of description, be referred to herein as the "solution". The charge should be very fluid, and should preferably contain three or four times as much water as mineral,—some of which water may be added to the mixture after it has been transferred to the tank A.

Most of the solution and the solution-coated mineral particles rise immediately to the surface, from which they may be skimmed; but considerable quantities of the solution-coated concentrates are enveloped by and entrapped in the sands which settle to the bottom of the tank. For the primary purpose of freeing these particles from the sand and permitting them to float on the surface, the vertical rotating agitator shaft B, and its adjuncts, are provided. Arms D are secured to this shaft near the bottom of the tank; and as the shaft slowly rotates they gently lift the mass of sands from the bottom and overturn it, and prevent it from packing, and thus permit the solution-coated particles to escape and float to the surface. These arms D are provided near their outer ends with lifting plows E whose front faces are set at an angle of about 45 degrees. To these arms, between the plows and the central shaft B, are secured inclined scraper blades F which act to gradually push the material outward into the path of the plows.

Defendant's Exhibit.

It is very desirable that some gas, preferably air, shall be blown into the charge near the bottom thereof. This gas assists in agitating the charge, but its chief value is in the assistance it renders in floating the solution-coated particles to the surface. It is clear that some of these particles may be so large and heavy that the coating thereon may not be able to buoy them up,—this being especially true in case the liquid used is thin and light,—as the kerosene-bitumen solution. The gas bubbles, however, not only tend to attach themselves to the solution-coated particles and to buoy them up, after the fashion of balloons, but the water is caused to dissolve the gas to its maximum capacity. This dissolved gas tends to again separate from the water, and attach itself in minute globules to the solution-coated particles, thus buoying them up and assisting their flotation. It is thought that any gas which will not chemically combine with the charge may be employed in the manner and for the purpose stated, but it is definitely known that air, carbon dioxide, hydrogen, and marsh gas may be used,—air appearing to be rather the most efficient as well as the cheapest.

This gas may be injected in any way, and by any means; but very efficient means for this purpose are shown in the drawings,—said means consisting generally in making the shaft B and arms D hollow, and providing the latter with discharge openings, and blowing the gas down through the shaft. The specific construction is as follows: The head of the shaft above

the driving gear b^4 is provided with a solution and air box G which remains stationary while the shaft revolves, and is supplied by the solution pipe H and air pipe L. The box rests on the rotating shoulder b of the shaft B, and is held down to a tight joint by the collar b′ and lock nut cap b^2. Through the hollow shaft B extends a small solution pipe K the upper end of which is firmly inserted within the upward extension of the shaft and moves with, and as a part of it. Air enters the annular chamber g in said box, passing through a set of apertures g′ to the interior of shaft B. The solution enters a small annular chamber g^2 from which it passes by apertures g^3 into the top of the central pipe K. The air current for the charge passes down through the shaft into the hollow arms D from which it passes out through drop pipes d. The solution is delivered from the pipe K to a series of radiating pipes k, which are secured to the arms D, and is discharged from branch pipes k′. This solution tends to attach itself to those particles, not already coated, but which it will adhere to, and thus assists their flotation. The introduction of air and solution renders the separation substantially complete, that is to say it causes substantially all of the particles which exhibit preferential adhesion for the solution to become coated thereby and floated to the surface.

The shaft B at its lower end has a stepped bearing which is supported on a pedestal M, provided with a wooden block m, which supports the moving wear plates m′ of the shaft. Lubricating water, un-

Defendant's Exhibit.

der pressure, is introduced through the pipe O and
1/05 finds ~~fings~~ its way out from the bearing into the tank. The sides b^5 of the shaft are carried down below the bearing so as to leave an annular space between them and the pedestal. This annular space is intended to constitute an air bell designed to assist the lubricating water in excluding sand from the bearing. The air supplied to it is maintained by a small stream of air which escapes beneath the bell through the pipe O′.

A spiral skimming bar P (two are shown) which is preferably secured to the rotating shaft B so as to extend through the floating layer of concentrates, solution and air bubbles, acts to direct this floating layer into the settling chamber R, and to overflow outlet a^3. This chamber is separated from the rest of the tank by a partition r, the upper edge of which, between the points r and r′, is submerged sufficiently to allow the floating layer and some of the muddy water to pass over it, while the edge of this partition, between the points r and r^2, is raised above the liquid so as to retain everything passing into it. There is an overflow outlet a^3 from this settling chamber through the side of the tank,—which outlet is partly surrounded by the elevated part of this partition.

Owing to the agitation within the tank, caused by movement of the arms and the rising air bubbles, the water even near the top is not clear, but turbid or muddy with slimes or fine particles of the non-coated minerals, which do not settle rapidly enough

to get out of the way. The floating concentrates are carried mainly at the lower surface of the floating layer where it is in contact with the water. The bottom of the overflow outlet must be below the surface level of the water in order to clear them, and must therefore allow a portion of the water to pass out with the skimmings. This muddy water would therefore carry its suspended particles of the worthless minerals, which would make the concentrates impure.

The settling and washing chamber is designed to lessen or prevent this evil. As the floating material passes over its submerged edge it escapes from the swift current and rising air bubbles, so that in its comparative quiet the slimes have a better opportunity to settle out of the way. The box is divided into compartments by submerged partitions r^4, as shown, each compartment terminating in a hopper shaped bottom, with discharge openings r^5 through which the settled slimes may pass out again into the tank. Projecting shields r^6 prevent the air bubbles from entering the hoppers and disturbing their quiet.

The passage of the floating material over several of these hoppers settles most of the slime before reaching the overflow outlet. Before reaching the outlet, however, the skimmings pass over a stream of clean wash water, introduced at the point s′ through the pipe S shown. This wash water is delivered under constant head from a supply tank. Its quantity is made equal to that passing out through the discharge gate

Defendant's Exhibit.

with the skimmings; so that this discharge, being supplied entirely by the pure water close at hand, contains little or none of the muddy water which is thus held back in the tank. It is evident that the incoming and outgoing streams are self-adjusting, because if too much enters, the general level rises and a large stream flows from the orifice. The flow of floating layer over the submerged partition of the settling chamber, and on to the overflow outlet may be induced by properly directed air jets blown onto said floating layer from jet openings t in one or more pipes T.

Having described my invention, I claim:

C celed
11/04.

~~1. The combination of a tank having an overflow-outlet, a rotary agitator, and means directing the floating surface layer to said overflow outlet, substantially as described.~~

C celed
24/05

~~1-2. The combination of a tank having an overflow outlet, with a rotatable agitator, and a curved skimming bar secured thereto and adapted to direct the floating layer of coated concentrates toward said overflow outlet, substantially as specified.~~

1- ~~2~~ ~~3~~. The combination of a separating tank having an overflow outlet, and a submerged settling chamber in said tank discharging through said outlet, with a

ar. /05

ta
rotable ~~curved~~
skimming bar supported in said tank for directing the floating layer of concentrates into said settling chamber and toward said overflow outlet, substantially as specified.

Defendant's Exhibit.

2 ~~3-~~ ~~4.~~ The combination of a separating tank containing a submerged settling chamber at one side thereof,—through whose side there is an overflow outlet from said chamber,—said chamber being formed by a partition which is partly submerged, and said chamber being divided into a plurality of hopper shaped compartments, each having a discharge opening through its lower end, substantially as specified.

3-~~4.~~ 5. The combination of a separating tank containing a submerged settling chamber at one side thereof,—through which side there is an overflow outlet from said chamber,—said chamber being formed by a partition which is partly submerged, and said chamber being divided into a plurality of hopper shaped compartments, each having a discharge opening through its lower end, and a shield below each of said discharge openings, substantially as specified.

4- ~~5~~ ~~6.~~ The combination of a separating tank containing a submerged settling chamber at one side thereof, said settling chamber having an overflow outlet through one side of the tank, and said settling chamber being formed by a submerged partition which projects above the surface of the fluid charge around said outlet but is at other places submerged below the floating layer on the surface of said charge, with a skimming bar which is supported in the tank and is adapted to direct said floating layer over the submerged top of said partition into the settling chamber and toward the overflow outlet therefrom, substantially as specified.

Defendant's Exhibit.

5- 6 7. The combination of a tank having an overflow outlet, and a vertical rotatable shaft in said tank having agitator arms located near the bottom of the tank, with a submerged settling chamber in said tank discharging through said overflow outlet, the inner partition of said chamber being extended around said outlet above the surface of the liquid charge and being submerged at other points below the floating layer of concentrates, and a spiral skimming bar secured to the shaft so as to project through said layer whereby it directs the layer of concentrates into said settling chamber, substantially as described.

C celed ar 1/04.

8 The combination of a tank having an overflow outlet, agitating mechanism therein, means for washing the floating layer, and means for collecting said layer and directing it to said outlet, substantially as described.

6- 7- 7- A separating tank having a submerged settling chamber at one side, and an overflow outlet from said chamber through said side, the inner wall of said chamber being above the surface of the fluid adjacent to said outlet, but submerged at other points below the floating layer of concentrates, and a pipe discharging clean wash water into said settling chamber close to said outlet, substantially as specified.

Ca eled ar. /04.

10- The combination of a separating tank containing agitating mechanism, with means for discharging a gas into the contained fluid charge, substantially as specified.

Defendant's Exhibit.

7 ~~11~~- 8- The combination of a separating tank containing agitator mechanism, with means for discharging into the contained fluid charge a gas and liquid lighter than water and immiscible therewith, substantially as specified.

Canceled Mar. 21 04

12- The combination of a separating tank containing a hollow rotating shaft, and hollow agitating arms connected therewith having discharge openings, whereby one may force a gas down through said shaft and arms and out of said discharge openings, substantially as specified.

8- ~~13~~ ~~9~~- The combination of a separating tank, a hollow shaft rotatably mounted therein having hollow connected agitator arms which are provided with a plurality of discharge openings, a pipe extending through said shaft, branch pipes connected with said pipe and extending toward the sides of the tank and having downward directed discharge openings, and means for forcing gas down through said shaft, and means for forcing a liquid down through said pipe, substantially as specified.

9- ~~14~~ ~~10~~ The combination of a separating tank, a rotatable agitator shaft therein having arms secured to it near the bottom of the tank, said arms having lifting plows near their outer ends and inclined scrapers between said plows and the shaft, substantially as described.

Defendant's Exhibit.

'ancelled r. 21/04.

15- The combination of a tank, with a vertical agitator shaft therein having a bell shaped lower end, a pedestal which is embraced by said lower end whereby the shaft is supported, and means for discharging water into said bell shaped shaft end, substantially as specified.

10-~~16~~- ~~11~~- The combination of a tank, with a vertical agitator shaft therein having a bell shaped lower end, a pedestal which is embraced by said lower end whereby the shaft is supported, and means for discharging water into said bell shaped shaft end, and means for discharging a gas into said bell-shaped end, substantially as specified.

---

ab. A M. 21/04.

17. The combination of a separating tank having an overflow outlet, agitating mechanism, and means of discharging jets of air onto the floating surface layer to move it toward the overflow outlet, substantially as specified.

11- ~~13~~ ~~18~~. The combination of a separating tank having an overflow outlet, agitating mechanism, a skimming bar, and a pipe having jet openings arranged over the surface of the charge in the tank to move the floating surface layer toward said overflow outlet, substantially as specified.

In testimony whereof, I hereunto affix my signature in the presence of two witnesses.

EDMUND B KIRBY

T L SAVAGE
E T EASTMAN } Witnesses.

Defendant's Exhibit.

State of Washington }
County of Stevens } ss.

EDMUND B. KIRBY, the above named petitioner, being duly sworn, deposes and says that he is a citizen of the United States and a resident of Rossland, in the province of British Columbia and Dominion of Canada, and that he verily believes himself to be the original, first and sole inventor of the improvement in SEPARATING TANKS, described and claimed in the annexed specification; that he does not know and does not believe that the same was ever known or used before his invention or discovery thereof; or patented or described in any printed publication in the United States of America or any foreign country before his invention or discovery thereof or more than two years prior to this application; or in public use or on sale in the United States for more than two years prior to this application; and that no application for foreign patent on said invention has been filed by him or his legal representatives or assigns, in any foreign country.

EDMUND B. KIRBY

Sworn to and subscribed before me, this 4th day of December 1903.

JOHN A. KELLOGG

[SEAL] Notary Public

Notary Public for State of Washington,
residing at Northport Washington.

Defendant's Exhibit.

M. E. C. 2—260

Div. . . . . . Room No .315 Paper No. 1

Address only "The Commissioner of Patents, Washington, D. C."

All communications respecting this application should give the serial number, date of filing, and title of invention.

DEPARTMENT OF THE INTERIOR

UNITED STATES PATENT OFFICE

WASHINGTON, D. C., January 29, 1904.

Mailed " " "

EDMUND B. KIRBY,

Care Thurston & Bates,

Cleveland, Ohio.

Please find below a communication from the EXAMINER in charge of your application. #185,475, filed December 17, 1903, for Separating Tank.

F. I. ALLEN.

Commissioner of Patents.

"Seggregation", line 2, page 2, should be changed to "segregation" *b* should be inserted in the drawing. "Fings", page 5, line 16, should be changed to "finds". The submergence of the wall of the chamber R between the points r and r′ must be shown in the drawing, as must the elevation of the rest of the wall.

Claim 1 is rejected in view of 228,125, Seymour,

May 28, 1880; 354,104, Deam, December 14, 1886; or 482,582, Meinicke, Sept. 13, 1892, Washers, D.

Claim 2 is rejected in view of Deam and Meinicke, cited.

Claim 3 fails to distinguish patentability from 396,-400, Guild, January 22, 1889, Steam Boilers, Cleaners.

Claim 4 may possibly be allowed, as may also claims 5, 6 and 7.

Claim 8 is rejected in view of the references for claim 1.

Claim 9 may possibly be allowed.

Claim 10 is rejected in view of 682,412, Perry, Sept. 24, 1901, Metallurgy, Solution and Precipitation, Apparatus.

Claim 11 is rejected in view of 725,609 Wolfe, April 14, 1903; 469,599, Rouse, Feb. 23, 1892, Washers, A, and any instance in which gas is employed in conjunction with oil for separating minerals—

British patent 12,778, Lake, June 4, 1902, Washers.

Claim 12 is rejected in view of Perry, cited.

Claim 13 may possibly be allowed.

Claim 14 fails to distinguish patentability from 73,-839, Rivot, January 28, 1868, Grinding Mills, Chasing.

Claim 15 is regarded as lacking invention in view of 525,443, Carman et al., Sept 4, 1894, Grinding Mills, Compound Movement; and 650,581, Ernsberger, May 29, 1900, Amalgamators, Plate. See also 445,430, McLanahan et al., Jan. 27, 1891, Washers, F.

Claim 16 may possibly be allowed.

Defendant's Exhibit.

Claim 17 is rejected in view of 325,104, McCormick, August 25, 1885, Washers, C, and 479,453, Peck. July 26, 1892, Washers, D.

Claim 18 may possibly be allowed.

Lewis B. Wynne
Examiner,
Division XXV.

T. F. Mitchell

Mail Room Serial No. 185.475 Paper No. 2
Mar 21 1904
U. S. Patent Office.

Patent Office
Mar 22 1904
Division XXV

Cleveland, O., March 18, 1904.

Room No. 315

The Hon. Commissioner of Patents,
Washington, D. C.

Dear Sir:

In the matter of the application of Edmund B. Kirby, No. 185,475, filed December 17, 1903, for Separating Tank,

Amendment is made as follows:

1. Cancel claims 1, 8, 10, 12 and 15.

2. In claim 2 insert the word *curved* before the word "skimming", in line 2.

Defendant's Exhibit.

3. In claim 3 insert the word *curved* before the word "skimming", in line 3.

4. Cancel claim No. 17, and substitute therefor the following:

Canceled Mar. 24/05.

A ~~12. The combination of a separating tank, having an overflow outlet, agitating mechanism in said tank, and a pipe, arranged above the surface of the charge in said tank, and having jet openings which are directed at an angle on to the surface of the charge and toward said overflow outlet, substantially as specified.~~

5. Renumber the remaining claims, in order.

Respectfully
EDMUND B KIRBY
By Thurston & Bates
his attorneys

Remarks:

The references cited against claim 2 fail to show a curved skimming bar *secured to the rotating agitator*, and therefore do not appear to meet the terms of this claim.

The reference cited against claim 3 probably met the second claim as originally presented. It is now amended to include a *curved* skimming bar, which the reference does not show, and we therefore request its allowance.

Claim 8, which was originally Claim 11, specifies means for discharging into the tank, not only a gas, but oil, and for this reason it does not appear to us

Defendant's Exhibit.

that this reference cited affords sufficient grounds for rejection.

Claim 10, which was originally Claim 14, describes a construction which, in operation, not only lifts the pulverized ore from the bottom of the tank, but creates a circulation of the fluid and mineral particles held in suspension,—the path of said circulation being upward near the tank walls, and downward near the center of the tank. The inclined scrapers take the granular material, which falls to the bottom, near the center of the tank, and push it outward, to points where the lifting plows, which are secured to the outer ends of the arms, lift it as stated. The claim is specific, being limited to the particular relative arrangement of the lifting plows and inclined scrapers, and, therefore, the Rivot patent does not seem to anticipate it.

We request an early and favorable action.

Respectfully,

THURSTON & BATES

Defendant's Exhibit.

M. E. C 2—260

Div. 25 Room 315 Paper No. 3

Address only "The Commissioner of Patents, Washington, D. C."

All communications respecting this application should give the serial number, date of filing, and title of invention.

DEPARTMENT OF THE INTERIOR

UNITED STATES PATENT OFFICE

WASHINGTON, D. C., April 11, 1904.

Mailed. " " "

EDMUND B. KIRBY, U. S. Patent Office.

Care Thurston & Bates,

Celveland, Ohio.

Please find below a communication from the EXAMINER in charge of your application. #185,475, filed December 17, 1903, for Separating Tank.

F. I. ALLEN.

Commissioner of Patents.

Case as amended March 21, 1904, further considered.

Claim 1 is rejected in view of the previously cited references, (Deam and Meinicke) and 258,578, Hamilton, May 30, 1882, Amalgamators, Lead. In view of Hamilton, the curvature of a skimming bar cannot impart patentability.

Since claim 2 does not specify a rotating skimming

Defendant's Exhibit.

bar, the stationary curved bar of Guild meets the 2nd claim. The bar should be specified as rotatable.

Claims 3, 4, 5, and 6 and 7 have been allowed.

Claim 8 may possibly be allowed.

Claim 9 has been allowed.

Claim 10 may possibly be allowed.

Claim 11 has been allowed.

Claim 12 is rejected in view of 393,454, Shields, Nov. 27, 1888, Amalgamators, Mercury. See also 414,962, Anderson, Nov. 12, 1889, Washers, A.

Claim 13 has been allowed.

LEWIS B WYNNE
Examiner,
Division XXV.

T. F. Mitchell

Mail Room
Mar 24 1905
U. S. Patent Office.

Patent Office,
Mar 25 1905
Division XXV.
Serial No. 185.475 Paper No. 4

CLEVELAND, OHIO, March 20, 1905

Room No. 315.
COMMISSIONER OF PATENTS,
Washington, D. C.

Dear Sir:—

In the matter of the application of Edmund B. Kirby for Separating Tanks, filed Dec. 17, 1903, Serial No. 185,475, last Office action April 11, 1904.

Amendment is made as follows:

1. In claim 2, original 3, line 3, before the word

"skimming" cancel the word "curved", and substitute *rotatable;* this amendment is made in conformance with the examiner's suggestion in order to render the claim allowable.

2. Cancel claims 1 and 12. It is thought that the above amendment places the case in condition for allowance, and it is requested that if so it be passed to issue.

Respectfully,

E. B. Kirby,

By Thurston & Bates,

Attys.

Defendant's Exhibit.

2—260

Div. 25 Room 315 Paper No. 5-

Address only "The Commissioner of Patents, Washington, D. C."

All communications respecting this application should give the serial number, date of filing, and title of invention.

DEPARTMENT OF THE INTERIOR,

UNITED STATES PATENT OFFICE

WASHINGTON, D. C., March 29, 1905.
Mailed " " "

EDMUND B. KIRBY,
Care Thurston & Bates,
1028 Soc. for Sav. Building, Cleveland, Ohio.

Please find below a communication from the EXAMINER in charge of your application. #185,475, Separating Tank, filed Dec. 17, 1903.

F. I. ALLEN
Commissioner of Patents.

Case as amended Mar. 24, 1905, further considered. The case awaits compliance with the formal requirements expressed in the first five typewritten lines of the office letter of Jan. 20, 1904.

LEWIS B. WYNNE
Ex'r. Div. XXV.

T. F. Mitchell.

Defendant's Exhibit.

Mail Room
Apr 4 1905
U. S. Patent Office.

Patent Office
Apr 5 1905
Division XXV.

Apr 3rd, 1905.

Serial No. 185,475 Paper No. 6

Room 315,

COMMISSIONER OF PATENTS,
Washington, D. C.

Dear Sir:—

In the matter of the application of Edmund B. Kirby, for Separating Tanks, filed Dec. 17th, 1903, Serial No. 185,475, last Office Action March 29th, 1905.

Amendment is made as follows:

1. Page 2, line 2,—change "seggregation" to *segregation.*

2. Page 5, line 16,—change "fings" to *finds.*

Examiner is requested to kindly apply the reference letter b to the rotating shoulder of the shaft B on which the box G rests.

The draftsman has been requested to correct the drawings so as to show the submergence of the wall R between the points r and r′. It is thought that the elevation of the wall R between r r^2 is sufficiently plain from the drawings as they will appear when the above correction has been made.

Respectfully,
E. B. KIRBY
By Thurston & Bates.
his attorneys.

Defendant's Exhibit.

Account	Serial No. 185,475 Paper No. 6½
Account	Apr. 4/05
Edmund B. Kirby,	Filed 190
Ser. No. 185,475,	
Separating Tanks,	
Filed Dec. 17th, 1903.	April 3rd, 1905.

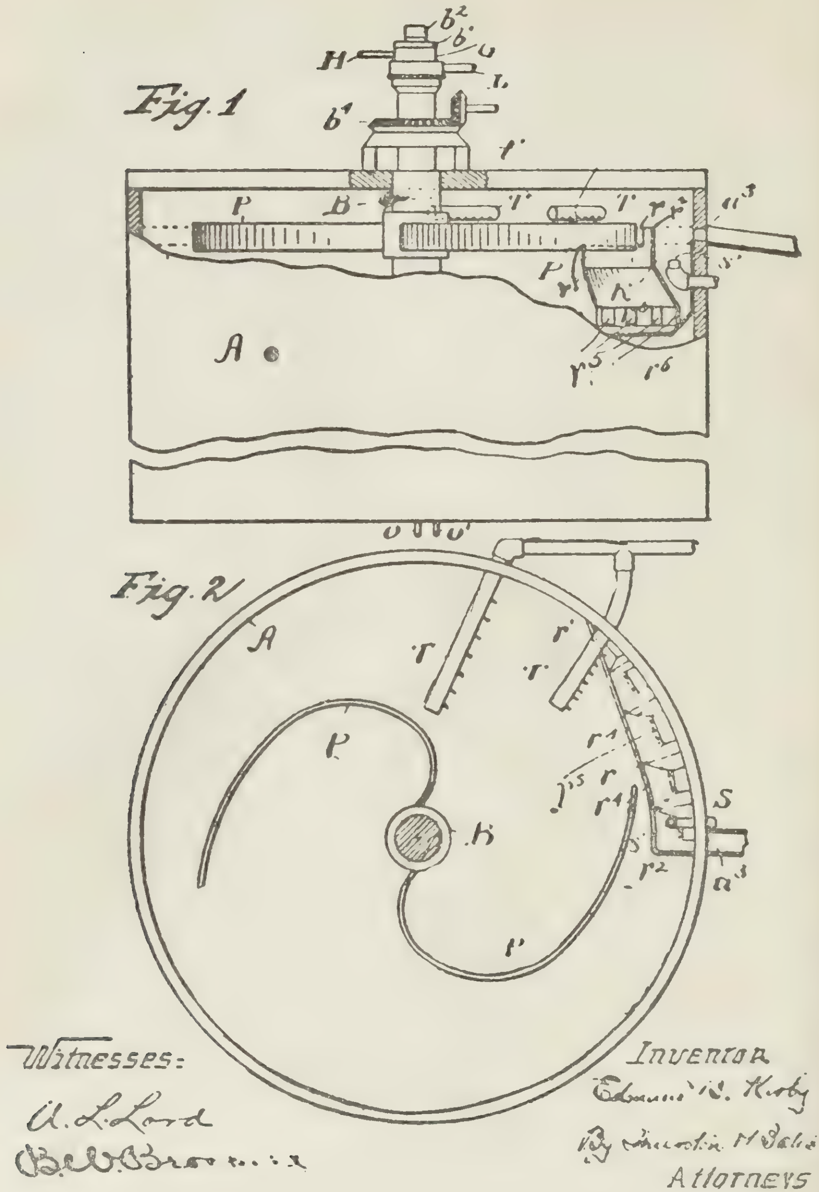
To The Hon. Commissioner of Patents,
Washington, D. C.

Sir:—

Please have a print made of the drawings in the above entitled case, and have the draftsman correct said drawings to comply with the Examiner's requirement of Jan. 20th, 1904, that the wall of the chamber R should be shown as submerged between the points r r',—and charge the same to our account.

Respectfully,
Thurston & Bates.

Defendant's Exhibit.



Defendant's Exhibit.

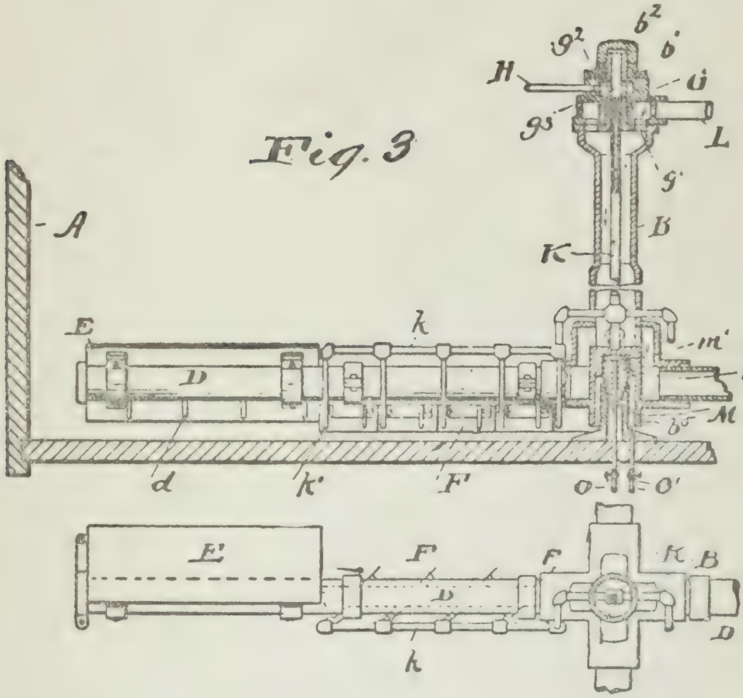


Fig. 4

Witnesses:

A. L. Lord

B. W. Brockill

Inventor

Edmund B. Kirby

By Thurston & Bates

Attorneys.

Defendant's Exhibit.

M. E. C. 2--260

Div. 25 Room 315 Paper No. 7

Address only "The Commissioner of Patents, Washington, D. C."

All communications respecting this application should give the serial number, date of filing, and title of invention.

DEPARTMENT OF THE INTERIOR

UNITED STATES PATENT OFFICE

WASHINGTON, D. C., April 27, 1905.

MAILED. " " "

U S PATENT OFFICE.

EDMUND B. KIRBY,

Care Thurston and Bates,

Cleveland, Ohio.

Please find below a communication from the EXAMINER in charge of your application. #185,475, filed December 17, 1903, for Separating Tank.

F. I. ALLEN

Commissioner of Patents.

Case as brought up by letter filed April 4, 1905, considered. Applicant is required to supply a sketch clearly indicating the changes to be made in the drawing.

LEWIS B. WYNNE

Examiner,

T. F. Mitchell Division XXV.

Defendant's Exhibit.

Mail Room Patent Office
Sep 29 1905 Sep 30 1905
U. S. Patent Office. Division XXV.

Serial No. 185,475 Paper No. 8
Room No. 315 Filed 190

In the application of Edmund B. Kirby
For Separating Tables
Filed December 17, 1903
Serial Number 185,475

We hereby appoint the firm of Thurston, Bates & Woodward, (consisting of E. L. Thurston, Albert H. Bates and J. M. Woodward) Registration Number 7162, as our substitute attorneys, with such full powers to act as we ourselves possess.

Thurston & Bates

Mail Room Patent Office.
Feb 3 1906 Feb 6 1906
U. S. Patent Office. Division XXV.
Serial No. 185,475 Paper No. 9
Room No. 315,

In the application of Edmund B. Kirby,
For Separating Tanks,
Filed December 17th, 1903,
Serial No. 185,475,

We hereby appoint the firm of Thurston and Woodward 1228 Citizens Building, Cleveland, Ohio,

Defendant's Exhibit.

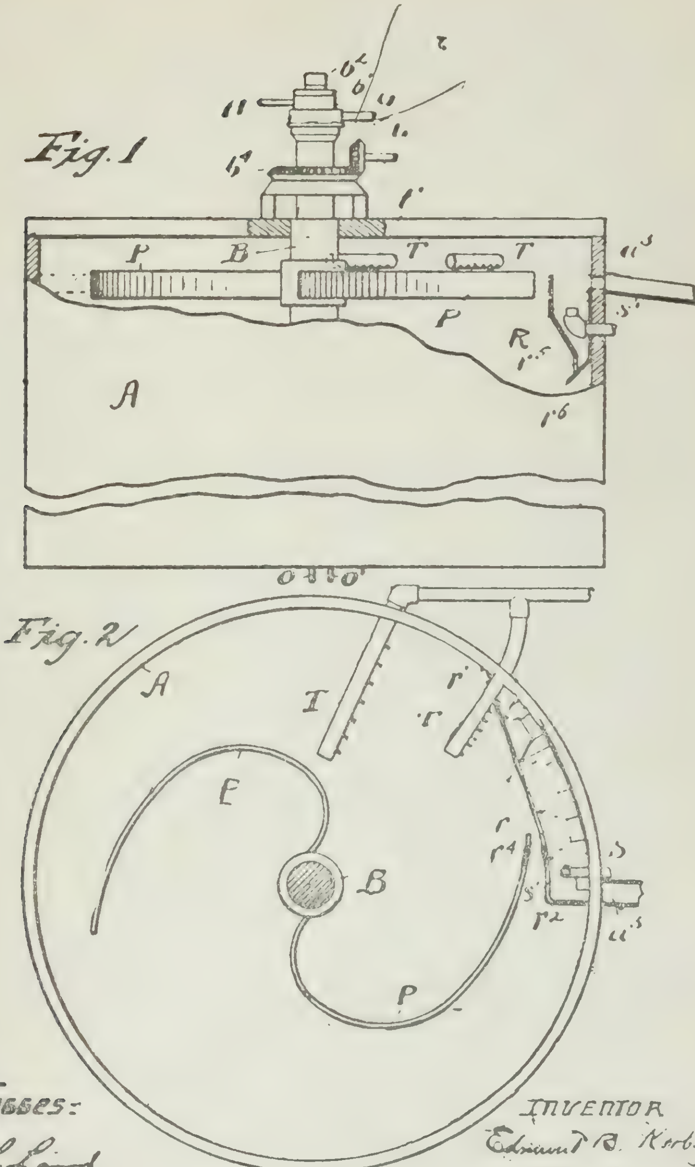
(consisting of E. L. Thurston, and J. M. Woodward,) Registration Number 7412, as our substitute attorneys, with such full powers to act as we ourselves possess, revoking the power heretofore granted to Thurston, Bates & Woodward.

THURSTON & BATES

We consent to the above:

THURSTON BATES & WOODWARD

Defendant's Exhibit.



Witnesses:

A. L. Lord.

B. W. Brockell

Inventor

Edward B. Kirby

By Thurston & Gates,

Attorneys

Defendant's Exhibit.

Mail Room
Apr 21 1906
U. S. Patent Office.

CLEVELAND OHIO April 19, 1906

Room 315

COMMISSIONER OF PATENTS,

Washington, D. C.

Sir:

In the matter of the application of Edmund B. Kirby, for Separating Tank, filed December 17, 1903, Serial No. 185,475, last Office action April 27, 1905.

It is requested that the Chief Draftsman correct the drawing as indicated by the lines in red ink in the accompanying print.

Respectfully,

EDMUND B. KIRBY
By THURSTON & WOODWARD
His attorneys

Defendant's Exhibit.

Mail Room
April 25 1906
U. S. Patent Office.

Patent Office
Apr 26 1906
Division XXV.

CLEVELAND, O. April 23, 1906

Room 315 Serial No. 185.475 Paper No. 10

HON. COMMISSIONER OF PATENTS,
Washington, D. C.

Sir:

In the matter of the application of Edmund B. Kirby, for Separating Tanks, filed December 17, 1903, Serial No. 185,475, last Office Action April 27, 1905.

In conformance with the requirement of the Examiner, we have, in a separate letter, requested the Patent Office Draftsman to correct the drawings so as to indicate the structure of the settling compartment.

It is believed that the correction of the drawings places the case in condition for allowance.

Respectfully submitted,
EDMUND B. KIRBY
By THURSTON & WOODWARD
His attorneys

Defendant's Exhibit.

SM

Issue Division. Serial No. 185,475

All communications should be addressed to "The Commissioner of Patents, Washington, D. C."

UNITED STATES PATENT OFFICE,

DEPARTMENT OF THE INTERIOR,

WASHINGTON, D. C., May 24, 1906.

EDMUND B. KIRBY,
C/o Thurston & Woodward,
1028 Soc. for Savs. Bldgs.,
Cleveland, Ohio.

Sir:

Your APPLICATION for a patent for an IMPROVEMENT IN SEPARATING TANKS, filed Dec. 17, 1903, has been examined and ALLOWED.

The final fee, Twenty Dollars, must be paid, and the Letters Patent bear date as of a date not later than six MONTHS from the time of this present notice of allowance.

If the final fee is not paid within that period the patent will be withheld, and your only relief will be by a renewal of the application, with additional fees, under the provisions of Section 4897, Revised Statutes. The office aims to deliver patents upon the day of their date, and on which their term begins to run; but to do this properly applicants will be expected to pay their final fees at least TWENTY DAYS prior to the conclusion

Defendant's Exhibit.

of the six months allowed them by law. The printing, photolithographing, and engrossing of the several patent parts, preparatory to final signing and sealing, will consume the intervening time, and such work will not be done until after payment of the necessary fees.

When you send the final fee you will also send, DISTINCTLY AND PLAINLY WRITTEN, the name of the INVENTOR and TITLE OF INVENTION AS AROVE GIVEN, DATE OF ALLOWANCE (which is the date of this circular), DATE OF FILING, and, if assigned, the NAMES OF THE ASSIGNEES.

If you desire to have the patent issue to ASSIGNEES, an assignment containing a REQUEST to that effect, together with the FEE for recording the same, must be filed in this office on or before the date of payment of final fee.

After issue of the patent uncertified copies of the drawings and specifications may be purchased at the price of FIVE CENTS EACH. The money should accompany the order. Postage stamps will not be received.

Very respectfully,

F. I. ALLEN

Commissioner of Patents.

In remitting the final fee give the serial number at the head of this notice.

Uncertified checks will not be accepted.

Defendant's Exhibit.

ᵛCertificate of Deposit.

$20—Received S
Nov 24 1906
Chief Clerk
U. S. Patent Office

November 24, 1906

COMMISSIONER OF PATENTS,
Washington, D. C.

Dear Sir:—

In the matter of the application of Edmund B. Kirby for an improvement in Separating Tanks filed December 17, 1903 Serial No. 185,475. allowed May 24, 1906 we hand you herewith as final Government Fee $20.⁰⁰ in the form of a certificate of deposit.

Yours truly,

THURSTON AND WOODWARD

Defendant's Exhibit.

SM 2—183.

Issue and Gazette Division. Serial No. 185,475

All communications should be addressed to "The Commissioner of Patents, Washington, D. C."

DEPARTMENT OF THE INTERIOR,

UNITED STATES PATENT OFFICE,

WASHINGTON, D. C., Nov. 24, 1906.

EDMUND B. KIRBY,
C/o Thurston & Woodward,
1223-1229 Citizens' Bldg.,
Cleveland,
Ohio.

Sir:

Your application for a patent for an IMPROVEMENT IN SEPARATING TANKS, filed Dec. 17, 1903, has been examined and again ALLOWED.

The final fee, TWENTY DOLLARS, in the above-entitled case was received Nov. 24, 1906.

Very respectfully,

F. I. ALLEN,
Commissioner of Patents.

[Here follows printed copy of Patent 838,626.]

Defendant's Exhibit.

1903 83. MILLS,
Ore and Coal:
Washers.

CONTENTS:

Print Apr. 10. 1905
Application ———— papers.
1. Rej. Jan. 20. 1904.
2. Amendment A Mar 21. 1904
3. Rej. Apr. 11. 1904.
4. Amendment Mar. 24. 1905.
5. Letter Mar. 29. 1905.
6. Amendment Apr. 4, 1905.
6½ Letter to draftsman " " "
7. Letter Apr. 28. 1905.
8. Sub. P. Atty Sept. 29. 1905
9. " " " Feb. 3. 1906
10. Letter to Office Apr. 25. 1906.
11.
12.
13.
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21.
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TITLE:

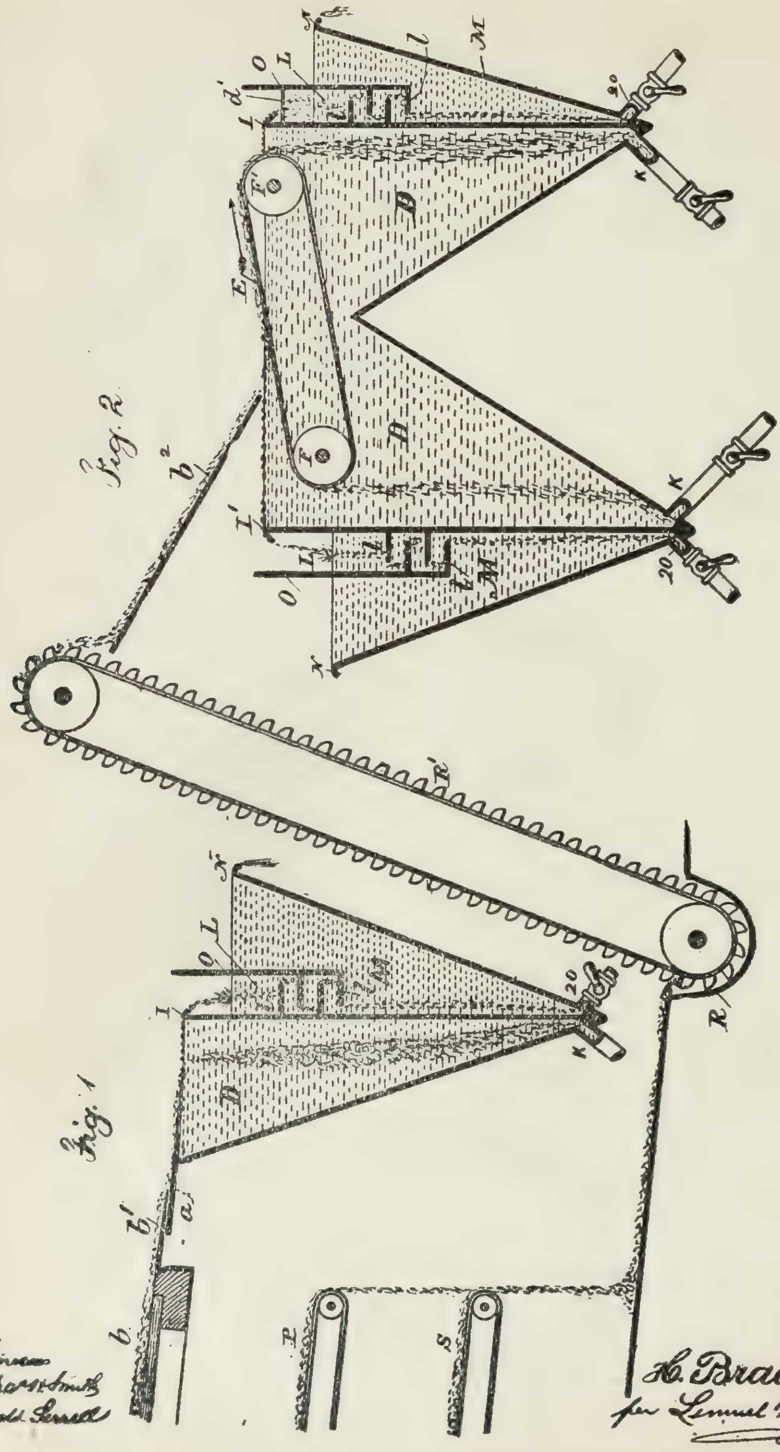
Improvement in Separating Tanks

(No Model.) 2 Sheets—Sheet 1.

H. BRADFORD.

METHOD OF SAVING FLOATING MATERIALS IN ORE SEPARATION.

No. 345,951. Patented July 20, 1886.



Witnesses
Chas. H. Smith
Harold Serrell

Inventor
H. Bradford.
per Lemuel W. Serrell att'y

(No Model.) 2 Sheets—Sheet 2.

H. BRADFORD.

METHOD OF SAVING FLOATING MATERIALS IN ORE SEPARATION.

No. 345,951. Patented July 20, 1886.

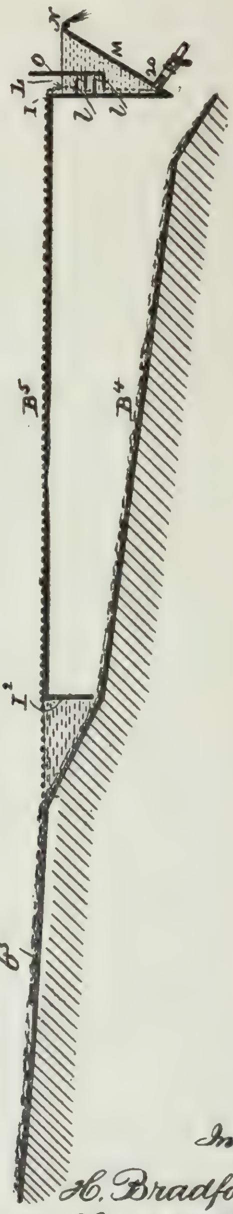


Fig. 3

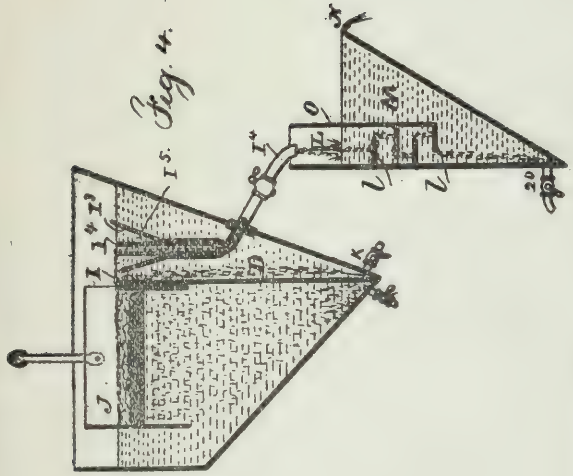


Fig. 4.

Witnesses

Chas H. Smith

Harold Serrell

Inventor

H. Bradford

per Lemuel W. Serrell att'y

UNITED STATES PATENT OFFICE.

HEZEKIAH BRADFORD, OF PHILADELPHIA, PENNSYLVANIA.

METHOD OF SAVING FLOATING MATERIALS IN ORE-SEPARATION.

SPECIFICATION forming part of Letters Patent No. 345,951, dated July 20, 1886.

Application filed June [illegible], 1885. Serial No. 169,342. (No model.)

To all whom it may concern:

Be it known that I, HEZEKIAH BRADFORD, of Philadelphia, in the State of Pennsylvania, have invented an Improvement in Methods of Saving Floating Materials in Ore-Separation, of which the following is a specification.

Almost all metallic ores—coal and other substances—when pulverized, contain a greater or less proportion of particles of ore or metal that will, even if pulverized in water, float on the surface of the water, and the finer the substances are pulverized the greater the proportion of floating particles. These floating particles appear to possess some peculiar quality which repels the water from their surfaces, especially when such particles are exposed, even momentarily, to atmospheric air, and when such exposure takes place the water is repelled from a sufficient portion of their surfaces to cause such particles to float off on the surface of the waste water from the other particles that sink in the water.

In concentrating ores they should be pulverized fine enough to liberate the metallic particles and the particles of native metals from their gangue. They are then, or should be, sized with screens. The larger sizes are, or should be, concentrated in jigs. The finer sizes are, or should be, concentrated by concussion-tables similar to the "Rittinger table," or by some of the various vanning-machines.

In amalgamating ores the quicksilver will not act on the base metallic ores; neither will it act on the particles of native metal unless the particles are brought in contact with the quicksilver, and consequently all the particles that float off over the amalgamating-pan are lost.

In the concentration of coal from slate as heretofore practiced a considerable proportion of coal, iron pyrites, and some slate will float off and be lost, and there are many other substances which while being concentrated or washed in water have heretofore floated off and been lost.

In the drawings, Figure 1 is a section representing my improvement as applied to the separator known as the "Rittinger table." Fig. 2 represents the improvement as applied to an ore-separator of the class known as the "Frue vanner." Fig. 3 represents the improvement as adapted to a trough or similar delivery device through which the tailings pass, and Fig. 4 represents the improvement as adapted to the tailings from a jig.

My present invention consists in a method of saving floating materials in ore-separation by passing such floating materials along upon the surface of the water, with but little agitation of the water, thus preventing such materials from subsiding, and then causing the water and floating materials to plunge or fall into a water-receptacle, and retaining said floating materials in said receptacle until they lose their floating power and sink. To accomplish this I attach to the end of the table *b* a metal plate, *b′*, on a level with the table and of the same descent, and fit it so evenly as to cause no ripple in the water as it passes from the table to the plate. This plate is wide enough to catch all the tailings, the waste water, and the floating material as these substances leave the lower end of the table, and catch none of the concentrations, and as the line where the concentrations and tailings meet on the table changes back and forth this plate must be so attached to the end of the table that it can be moved back and forth as this line changes on the table. This plate *b′* must be attached also as nearly parallel as possible with the line of motion of the table.

Under the plate *b′*, and as close to it as possible, I provide a stationary metal plate, *a*, which receives the water, the tailings, and the floating material without ripple, and conveys the same to the top of the water in tank D. This plate *a* is preferably a little more inclined than the plate *b′*, as it has no motion. Both plates should have just descent enough to deliver the substances upon the top of the water in tank D with as little force as possible, and the plate *a* should touch the top of the water, so that the substances will not plunge under the water of the tank D or make any unnecessary ripple; nor should said plate *a* dip under the water, as that would cause an eddy in the current on the top of the water by the discharge of the substances from plates *b′* and *a*, and this eddy, by detaining the floating particles, would cause some of them to sink

among the tailings. As soon as these substances strike the water of the tank D, the tailings will immediately sink to the bottom of the tank, while the floating particles will pass, with a part of the waste water, over the overflow I of tank D into a receptacle, L, in tank M, with a fall sufficient to plunge the floating particles under water. This receptacle L should be small enough so that the whole surface of the water therein will be constantly acted upon by the plunging water, in order to thoroughly wet the floating particles, some of which will rise many times to the top of the water before they get wet enough to sink; and to insure the fall of the water, so as to cover the whole surface of the receptacle L, a perforated plate, d', may be used, as shown in Fig. 2, with holes enough and large enough to shower the water over the whole of this receptacle L. In this receptacle L, I provide a series of shelves, l, to break the force of the plunging water, so that when it passes down below the lower shelf with the metallic particles it will produce no agitation in the main body of the water in the tank M, and the particles that floated are so thoroughly wet as to sink below the bottom shelf, and to continue to sink until they reach the bottom of tank M, and they will not float again without exposure to atmospheric air. The water will pass off at the overflow N of tank M free from floating material. Where there is not fall enough from the end of table b or the end of vanners P and S, or where plates like b' could not be attached for conveying the tailings, the waste water, and the floating materials directly to the tank D without ripple, the substances must be conducted to trough R, from which these substances must be raised by an elevator, R', high enough to be deposited in the trough or incline b', which will deliver them upon the belt E, a portion of which is immersed in water in tank D, and the upward motion of this belt will elevate these tailings and floating materials out of the water, so that atmospheric air will come in contact with the tailings. When the belt delivers these substances again to the water, the tailings will immediately sink in the water to the bottom of the tank D, while the particles that repel the water will float and pass off over the overflow I into a receptacle, L, of tank M, similar to that shown in Fig. 1, where all the floating particles will become wet enough to sink, and the waste water will pass away at the overflow N. All the particles that float on the top of the water, as the substances are deposited in the water on the belt E, will float out at the overflow I' into a tank similar to M, where these particles will sink and the waste water pass off free from floating material. The belt may be made of rubber, like a Frue-vanner belt, with ridges on both edges to prevent the substances from running over the sides of the belt, or it may be made of any other suitable material, but should have ridges at the edges of the belt. The belt should fit the tank closely, so that the floating particles from the lower end of the belt will pass off at the overflow I'. All the tanks should be discharged at the bottom continuously through stop-cocks or other equivalent means. Where the waste-water way has but little descent, I provide a trough, b^3, Fig. 3, at an incline just enough to carry off these substances a sufficient distance to procure, if possible, a depth for the dam I^2 of at least twelve inches. The floating particles will pass with a small portion of the waste water to the dam I, and the tailings will pass away at the bottom of the dam with part of the waste water, which will carry off all the tailings.

The dam I, vessel M, and the parts for saving the floating material are similar to those shown in Fig. 1.

Where the ore is too coarse in size to be concentrated on tables, it is generally concentrated in jigs, (see J, Fig. 4.) Any particles that float on the water will pass out of the jig J with the tailings at the overflow I. The tailings will sink in the water in the tank D as soon as they pass this overflow, and will be discharged at the bottom of the tank by the pipe and cock K, and the floating material will pass, with a portion of the waste water, into a receptacle, I^3, which is contracted at the bottom to a size just sufficient to form a pocket, I^5, that will hold an upright pipe, I^4, in the center of this receptacle, which pipe ought to be of sufficient size to carry off a part of the waste water and all of the floating material from the jig. The bottom of the pocket is extended through the side of the jig, and has a stop-cock at the end, where the waste water and the floating material should be continuously discharged into a receptacle, L, in the tank M. The conical receptacle I^3 should have a flat side toward the overflow, extending the whole length of the overflow of the jig, and should be placed just far enough, but no farther, from the overflow I to allow all the tailings to settle before the waste water and floating material reach the receptacle I^3. The reason for this is, that some of the floating particles have only a little floating capacity, and many will sink before they float far. When they once float over the receptacle I^3 with part of the waste water, the current caused by the suction of the discharge-pipe I^4 in the center of the receptacle I^3 will draw the floating particles, and the waste water and the floating material are discharged into the receptacle L in the tank M, where the floating material will be saved, as before described. Any particles that sink in the receptacle I^3 before they reach the pipe I^4 can be discharged from the receptacle by raising the pipe I^4 from the pocket.

All the tanks are discharged at the bottom through stop-cocks, which should be so regulated as to discharge just water enough to carry out their respective deposits.

If it should be desirable to again expose the tailings from tank D and trough B' to the action of atmospheric air, they can be conducted in any convenient way to a trough, like R, elevated by an elevator, like R', and delivered onto a belt, like E, in tank D, where such particles as would float could be saved.

The shelves in receptacle L, instead of being horizontal, may be placed at an angle sufficient to discharge the particles of floating material as fast as such particles settle on such slanting shelves—say at an angle of seventy-five degrees—which will prevent agitation in the water in the main body of the tank nearly or quite as well as the horizontal shelves, taking care to have ample room for the water to pass away between the shelves.

In depositing the water, tailings, and floating material on the belt E, a small portion of fine tailings may, in the agitation caused by such deposit, pass off into tank D at the lower end of belt. Any such tailings will sink in the tank and pass off at stop-cock K.

This improvement is available with ores or tailings that are either in a wet or dry condition. When such materials are in a dry condition, they are to be scattered upon the water by sifting or otherwise near the surface, so as to fall upon the water with but little concussion. A part of the metallic portions will float, and most of the earthy portions will absorb moisture and sink. I therefore do not limit myself to any particular manner of supplying the material to be operated upon, or of causing the particles that are to be separated to float.

I do not claim a separating device in which the water and tailings from a stamp or other reducing-machine pass through a pipe to a vessel in which the particles of ore are to be gathered as they float, because in so doing the materials that may have floated are carried down under water and considerable sinks. By my improvement any particles that come to the surface are kept up, so that they may not sink until they reach the place where they are saved.

I do not herein lay claim to the means employed for the conduct of the method, but reserve the right to apply for a separate patent thereon.

I claim as my invention—

The method herein specified of saving floating materials in ore-separation, consisting in passing the water and floating materials along in an open unobstructed sheet from the table or separating-machine with but little agitation of the water, thus preventing such materials from being carried beneath the surface and subsiding, then causing the water and floating materials to plunge or fall into a water-receptacle, and then retaining said floating materials in said receptacle until they lose their floating power and sink, substantially as specified.

Signed by me this 20th day of June, A. D. 1885.

HEZEKIAH BRADFORD.

Witnesses:
GEO. T. PINCKNEY,
WALLACE L. SERRELL.

UNITED STATES PATENT OFFICE.

CARRIE J. EVERSON, OF CHICAGO, ILLINOIS.

PROCESS OF CONCENTRATING ORES.

SPECIFICATION forming part of Letters Patent No. 348,157, dated August 24, 1886.

Application filed August 29, 1885. Serial No. 175,665. (Specimens.)

To all whom it may concern:

Be it known that I, CARRIE J. EVERSON, of Chicago, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Processes of Concentrating Ores; and I do hereby declare that the following is a full, clear, and exact description thereof.

The discovery which forms the basis of my invention is that metals and metallic substances in a comminuted state will unite with compounds of fats or oils and acids, and that such compounds will not unite with comminuted quartz or other rocky gangue. The essential feature of the method which constitutes my invention, therefore, consists in commingling with pulverized ore a fat or an oil, either animal, mineral, or vegetable, or a fatty constituent or acid of an animal or vegetable fat or oil, or any constituent of a mineral oil, together with an acid, either mineral or vegetable, or a soluble neutral or acid salt, for the purpose of effecting a union of the free metal or metallic portion of the ore with such admixed material, whereby the same may be retained in the subsequent separation of the quartz or other rock therefrom by washing or other suitable means.

The invention is more specially applicable to the treatment of ores in which the metal or metallic portion is mixed with quartz or other rock as distinguished from the mixture of mineral with clay, though it is applicable to ores containing alumina, together with quartz or other rock, to the extent of permitting the removal of the silica or sand.

The operation of concentration as a whole, or in its practical form as applied to the separation of rocky mineral ores, involves the reduction of the quartz or other rock containing the mineral to a powder, the addition thereto of the fat or oil and acid or salt, and the subsequent removal of the gangue.

If my invention is inapplicable to any particular rocky ores or class or classes of rocky ores, or to the concentration of any particular metal, such limitations are not now known to me. Its commercial value, however, will probably be restricted to its use in connection with ores bearing the precious metals, such as gold, silver, and copper.

Among the ores upon which I have operated successfully by means of my invention are the following: Ores containing native gold and silver, kerargyrite, argentite, argentiferous galena, and a variety of double and otherwise compound sulphides of silver, with copper, antimony, arsenic, and other base-metal sulphides. I have also operated successfully upon pyritic ores, white, yellow, green, and intermediate shades, having variable constituents of iron, copper, arsenic, and sulphur, and mostly auriferous, and having variable proportions of such constituents. I have also operated successfully upon ores containing tellurides of gold, silver, and lead, and others containing the oxides and carbonates of copper and the carbonate of lead. All the metals or metallic mineral portions of these ores are acted upon by the admixture described, in such manner as to permit the rocky gangue to be removed by a washing process, after which the several metals may be separated by the usual means.

In putting my invention into practice any fat or oil, and any acid, either mineral or vegetable, or any soluble neutral or acid salt, or any compound of fats and oils with appropriate acids, may probably be successfully employed, at least such is the case with all of these agents with which I have so far experimented. I have used petroleum and one of its several constituents—namely, paraffine-oils—also tallow, (melted,) lard, lard-oil, red-oil, (impure oleic acid,) cotton-seed oil, castor-oil, sperm-oil, and linseed-oil, and some combinations of these with each other. The acids which I have employed are sulphuric, hydrochloric, nitric, phosphoric, acetic, oxalic, tannic, and gallic. I have also used the following salts, to wit: the sulphates and chlorides of sodium, zinc, and copper, and the double sulphate of potash and alumina. The selection of the appropriate agents will, however, be largely determined in the practical working of my invention by the consideration of economy, which will obviously exclude the greater number of those above enumerated. A reasonably cheap and practicable use of my invention will be as follows, the quantity named being suitable for laboratory use and the character of the ore specified being substantially that of an ore upon which I have successfully operated by the preparation and in the manner hereinafter described.

Take an ore assaying twelve ounces per ton in silver and containing forty eight per cent. silica, 6.3 per cent. zinc, 1.5 per cent. copper, fifteen per cent. iron and aluminium, 6.5 per cent. lead, 14.18 per cent. sulphur, 7.19 per cent. arsenic. Of this ore take four (4) ounces by weight in pulverulent form, prepare a mixture containing sulphuric acid, cotton seed oil, and water, in all about twelve fluid drams, of which ten drams are of water and about two drams are acid and oil in the proportions of fifteen parts of the oil and two parts of the acid by measure. In making this fluid mixture the acid and oil are first mixed with each other, the acid being added to the oil very gradually, so that the temperature will not rise above 120° Fahrenheit. The stirring in of the acid should be thorough, as it tends at first to gravitate to the bottom. After a few hours, in a summer temperature, the mixture will be ready for use, and, preferably, in such a temperature should not be prepared long before using, though if it should have stood long enough to solidify it should be gently heated before adding the water thereto. In winter or in air-tight vessels it may be kept for a number of weeks or even longer, and then rendered fit for mixing with water by heating gently when required for use. The water may be advantageously added in installments of about three equal parts, and the mixture stirred after each addition of water until it stiffens. After stirring in the entire quantity of water the compound is added to the ore, the proportions of ore and compound being chosen with a view to producing a stiff mass after the materials have been incorporated, such proportions being therefore variable in different cases with this end in view. The stirring or incorporation of the ore with the liquid should of course be thorough for the purpose of bringing the mineral into contact with the oil and acid as completely as possible, and after such incorporation the mass is then in condition for the washing out of the quartz by the action of water which will be applied to the mass in sufficient quantities for this purpose. The washing should promptly follow the mixing, and in this operation the mass be opened out or broken up and thoroughly stirred in the water, in order that the sand or quartz may be freed and carried away. In treating so small a bulk as above specified the mass may be squeezed repeatedly in the hand in a basin of water, the substance so manipulated being expressed between the fingers each time it is squeezed, and thus made to expose new surfaces to the water from which the sand will be detached, so as to fall to the bottom of the basin. In practice upon large masses any vessel having an outlet or outlets at its bottom for the escape of the water and sand will be suitable for this operation of washing, and mechanical means will of course be employed to break up the mass. The concentrated mineral will accumulate in a pasty mass or lump or lumps and will contain the metallic portion of the ore, together with the hydrated oil and acid, which latter may be removed by heating and afterward roasting, or by other suitable means. The use of petroleum or of a constituent thereof, either by itself or in combination with tallow, (heated,) cotton-seed oil, or other fat or oil, will be even less expensive.

When petroleum or a constituent thereof is used the oil should desirably be first mixed with the ore, then water added containing a suitable amount of free acid or a soluble neutral or acid salt, the quantity of water being ample for the washing-out operation, which is to follow, and the quantity of acid sufficient to cut the sand away from the otherwise cohering mass.' In the case of petroleum or its constituent, paraffine-oil, one or two fluid drams of acid to one gallon of water is sufficient for this purpose. The petroleum which I have used was 30° Baumé, and I have found three fluid drams of oil abundant for properly moistening two ounces of heavy ore, or in the ratio of about a barrel of oil to the ton of ore, the amount being, of course, variable with the relative bulkiness of the ore.

In the use of petroleum, or of a liquid constituent thereof, like paraffine oil, the condition of the concentrated mass is more liquid than when a vegetable or an animal oil or a fatty constituent thereof is used, and a somewhat different means or method should be employed for removing the sand. In practice, the concentrate, after thorough agitation of the mass and detachment of the sand, will in this case be preferably removed by means of a constant overflow of water from a washing-out vessel, by which overflow the concentrate will be floated off. Devices and methods now well known in wet separation of ores will be suited to this part of the operation, bearing in mind that the sand and mineral are merely transposed or their relative positions are reversed, because the sand is heavier than the mixture of mineral, oil, and acid. A proper selection of devices for this purpose will be apparent to those skilled in the wet separation of ores. After removing the quartz or rock by washing or any suitable means the mineral may be roasted, in which operation the water, if present, will be dispelled, the oil will burn out, and the acid will be decomposed and eliminated, in the case of sulphuric-acid, which will commonly be used, by conversion into sulphurous-acid gas, which passes off. In case fixed oils are used the mass may be allowed to stand until the water has run off. To hasten the operation of removing the water the mass may be heated, say, to about 212° Fahrenheit or less, whereupon the water will generally be promptly freed and may be poured off or it may be evaporated. The operation of smelting is facilitated by the presence of the fat acting simply as a fuel.

The disposition made of the mineral or metal after concentration, whether by roasting and subsequent smelting or by smelting without previous roasting, or otherwise, belongs to the

after treatment and is not material to my present invention.

The proportions in which the acids or salts are added to the oils or fats may vary according to the kind of acid or oil employed, and also according to the kind of ore to be treated; and the manipulation of the substances employed may be varied from that above set forth in either formula given. These matters may be determined in individual cases by the operator; and I do not, therefore, restrict myself to any particular proportions of the substances employed, though I have above indicated proportions of certain acids and oils by one of the other of which practical results may be obtained upon almost all varieties of ores.

It is also not essential to my invention that the acid or salt employed with a vegetable oil be added to the oil before the incorporation of the oil with the ore, as it is entirely practicable, at least in most, and possibly in all, cases, to first mix such oil with the ore and thereafter add the acid, as set forth in the use of petroleum.

I am aware that it has been proposed in a patent to Tunbridge, No. 228,004, dated May 25, 1880, to recover finely comminuted metal held in suspension in water by the use of soap or a saponaceous compound formed by a partial or imperfect blending of an alkali or an alkaline salt with a fat or an oil. The action of the soap or saponaceous compound when diffused through hard water containing the metal in suspension is to form with the lime salt in the water a coagulum in which the particles of metal are enveloped and by which they are held during a subsequent removal of the water. When the water is soft a lime salt must be added to form the coagulum. I disclaim the use of any substance in connection with the fats and oils capable of saponifying them. I also disclaim the method set forth in said Tunbridge patent as being entirely dissimilar to that herein claimed. Said Tunbridge method is stated in said patent to consist "in first depriving the water of as much earthy non-metallic matter as possible," this being effected by any of the ordinary methods in use for that purpose, such as letting it stand until the earthy matter precipitates. My invention, on the other hand, has reference solely to the separation of metal or metallic mineral from earthy non-metallic matter, (rocky gangue,) and not to its subsequent separation from water. In the practice of my method, moreover, the metal or mineral and non-metallic matter (rocky gangue) are together and in the first instance mixed with the fat or oil, and the non-metallic matter is afterward separated from the metal or mineral by the peculiar action of the acid or soluble neutral or acid salt operating in the presence of water to detach the gangue from the mass.

With the understanding that I am not restricted in the matters mentioned, I claim, broadly—

1. In the separation of pulverulent ores containing rocky gangue, the method of treatment herein described, which consists in mixing with such pulverulent ore a fat or an oil or a constituent thereof, an acid or soluble neutral or acid salt, and water, finally breaking up the mass to allow the sand to separate therefrom.

2. The method, substantially as described, of separating metals or metallic minerals from rocky gangues, which consists in mixing a fat or an oil or a constituent thereof with pulverized ore and washing out the gangue with water containing an acid or a soluble neutral or acid salt.

In testimony that I claim the foregoing as my invention I affix my signature in presence of two witnesses.

CARRIE J. EVERSON.

Witnesses:

M. E. DAYTON,

G. F. LANAGHEN.

(No Model.)

H. J. WAGNER.

CHURN.

No. 373,113 Patented Nov. 15, 1887.

Fig. 1.

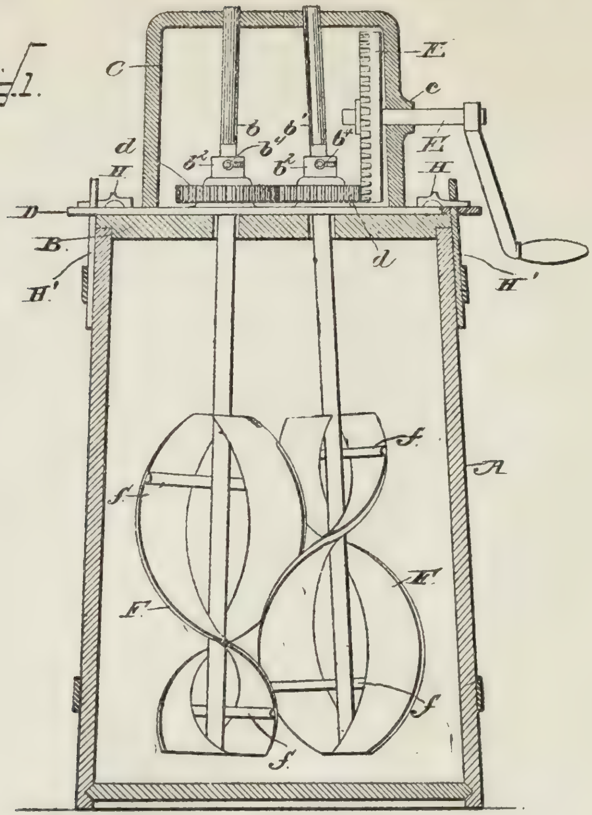


Fig. 2.

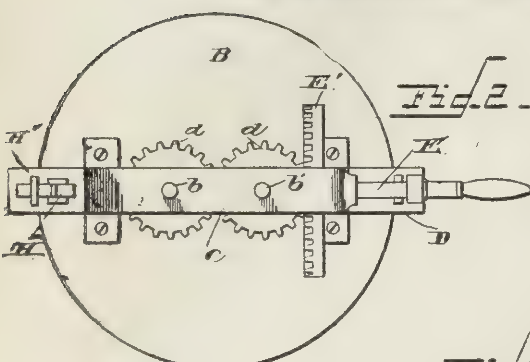


Fig. 3.

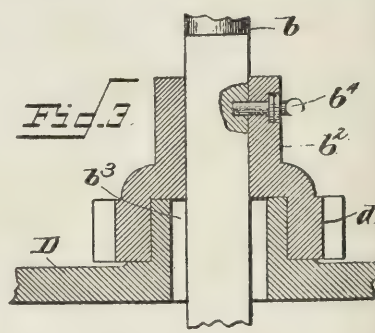
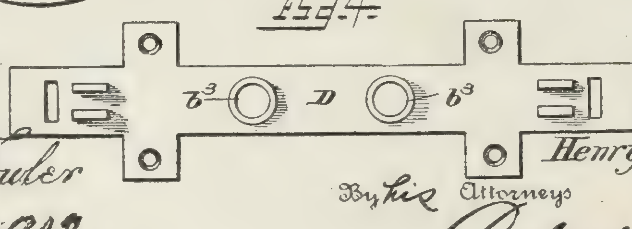


Fig. 4.



Witnesses

M. E. Fowler

E. G. Siggers

Inventor

Henry J. Wagner

By his Attorneys

C. A. Snow & Co.

UNITED STATES PATENT OFFICE.

HENRY J. WAGNER, OF DAYTON, MISSOURI.

CHURN.

SPECIFICATION forming part of Letters Patent No. 373,113, dated November 15, 1887.

Application filed June 24, 1887. Serial No. 242,412. (No model.)

To all whom it may concern:

Be it known that I, HENRY J. WAGNER, a citizen of the United States, residing at Dayton, in the county of Cass and State of Missouri, have invented a new and useful Improvement in Churns, of which the following is a specification.

My invention relates to churns; and it consists in the construction and arrangement of parts of the same, which will be more fully set forth hereinafter, and pointed out in the claim.

My present invention relates to an improvement on Patent No. 347,978, granted to me August 24, 1886.

The object of my present invention is to vary the construction of the mechanism shown and described in my patent above mentioned, so as to advantageously provide a churn more positive in its results, cleanly in its operation, simple and effective in its construction, and comparatively inexpensive in its manufacture.

The essential feature of my present invention is the use of suspended dashers devoid of bearing-surface at their lower portions and operated to revolve in reverse directions upon vertically-inclined shafts.

In the accompanying drawings, wherein like letters of reference indicate similar parts in the several views, Figure 1 is a vertical section of my improved churn. Fig. 2 is a top plan view of my improved churn. Fig. 3 is a sectional elevation of a portion of one of the dasher-shafts and its gearing. Fig. 4 is a top plan view of the top bearing-plate.

A indicates the churn-vessel, of suitable size and shape, which is provided with a detachable cover, B, situated on the upper portion of the churn-vessel and having a transversely-arranged metallic plate, D, slotted at its ends to receive the upwardly-projecting spring-plates H′, secured to the vessel A and engaged by the locking-bolts H on the ends of the said plate D. The construction as thus described is common to my patented device aforesaid, and I will now proceed to describe my improvement upon said device.

Secured to the cover B is a U-shaped bracket, C, closed at its upper side, and at its ends being firmly secured to said cover in any suitable manner. A boss, *c*, is formed in one side of the bracket C, and provides a bearing for a shaft, E, arranged horizontally therein, and having an operating-handle on its outer side; and on its inner end a face-gear, E′, is secured, and arranged in a plane at right angles to the plane of the shaft upon which it is mounted, as will be readily understood.

Two shafts, *b b′*, are vertically mounted in the said frame and at a slight incline to the perpendicular, being loosely secured at their upper ends in the top portion of the bracket C, and having bearing in the boxes b^2 b^2, adapted to fit over flanged openings b^3 in the transverse plate D. The boxes b^2 are formed with apertures, through which spring-pins b^4 engage the shafts, the said shafts being thereby retained in a suspended position. The boxes b^2 are integrally formed with horizontally-arranged spurs or gears *d d*, which rest on the top surface of the transverse plate D and are in mesh with each other and with the vertically-arranged wheel E′ at all times. The shafts *b b′* pass vertically through the blocks b^2 at an incline to the perpendicular and the gears *d*, and are locked in connection therewith, to suspend the same, as desired, by means of the pins b^4, secured to said boxes b^2, and adapted to engage openings formed in the shafts *b b′*, for securing the said shafts, as hereinbefore set forth.

On the lower ends of each of the shafts *b b′* spirally-arranged dashers F F are secured. These spiral blades are mounted in connection with said shafts *b* and *b′* by means of transversely-arranged arms *f*, which extend outwardly and are secured to the back sides of each of the blades or dashers, having the shafts for their centers in connection with each dasher. As seen in Fig. 1, the lower ends of the shafts *b b′* do not touch the bottom of the churn body or vessel A, and have no bearing-points at the lower ends thereof, being braced and supported in the cover B and the bracket C, and having a free suspension within the body of the churn, the lower ends of the dashers being farther apart than the upper ends. These dasher-blades and their shafts *b b′* are adapted to have a reverse revolution. This is accomplished by means of the gear E′ meshing

with the gears d, the gear d nearest the gear-wheel E′ being revolved in one direction, while the gear d on the other side of the first gear d is revolved in a reverse direction, as will be readily understood by those skilled in the art.

As hereinbefore set forth, the dasher-blades are formed spirally on two perpendicular shafts turning in opposite directions, giving a slightly angular horizontal circular motion to the dashers, which, crossing each other's circles, the lower ends moving in advance, lift the cream from the bottom, throwing it upward and outward, giving it a semicircular motion, which is continually intercepted in every direction by counter-currents from the oppositely-revolving dashers, causing thorough and equal agitation of the whole mass. In this movement air follows behind and under the blades, and oxygen of the air comes in contact and freely combines with every particle of cream. Thus oxygen combines with sugar of milk, producing lactic acid, which curds the caseine, thus separating it from the butter when the butter-globules are ruptured by agitation. This advantage will be readily appreciable to those skilled in the art of butter-making, and the advantageous action of the spirally-arranged dashers will be readily apparent in respect to the valuable infusion of oxygen.

In the operation of my improved churn no jarring or plunging motion is heard or felt, the operation being in a measure noiseless.

By the arrangement of the driving mechanism and dashers on the cover B, on removing the said cover to introduce hot or cold water for cleaning purposes all the operating parts are removed at one operation, and on replacing the cover the dasher-shafts will be in adjustment and in proper position without the necessity of any connection or manipulation.

The novelty and utility of my improved churn are apparent, and need not be further enlarged upon herein.

Having thus described my invention, I claim—

In a churn, the body A, having its cover or top provided with a plate, D, the latter having openings b^3 therein, and annular upwardly-extending flanges around the said openings, combined with the shafts b, carrying the dashers, the lower ends of the dasher-shafts being entirely disconnected from the body, the upper ends of the shafts being passed through the openings b^3, the gears d, recessed in the under side to fit over the flanges of the openings b^3 and turn around the same, said gears being separate from the shafts, boxes b^1, formed integral with the gears, a spring locking-pin, b^4, carried by the boxes to lock the boxes and gears to the shafts, a bracket, C, above the cover to receive the upper ends of the shafts b, and the gears d meshing with each other and the gear E′ with driving-shaft E, for the purpose set forth.

In testimony that I claim the foregoing as my own I have hereto affixed my signature in presence of two witnesses.

HENRY J. WAGNER.

Witnesses:

LUCY M. WAGNER,
R. D. RAMEY.

(No Model.) 3 Sheets—Sheet 1.

E. A. HOCKLEY.

ORE SLIMER.

No. 466,753. Patented Jan. 5, 1892.

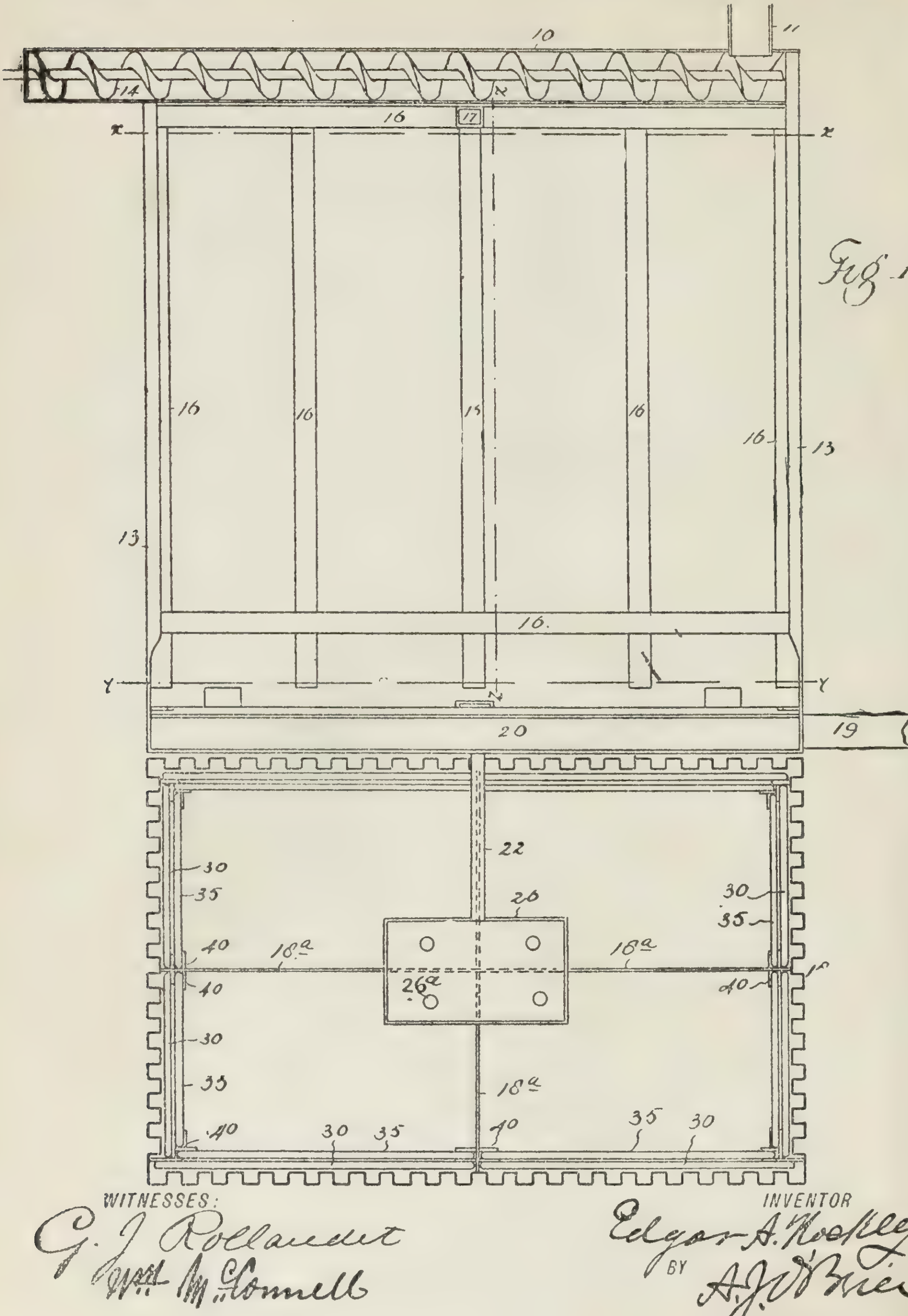


Fig. 1

WITNESSES:

G. J. Rollandet

Wm. McConnell

INVENTOR

Edgar A. Hockley

BY A. J. O'Brien

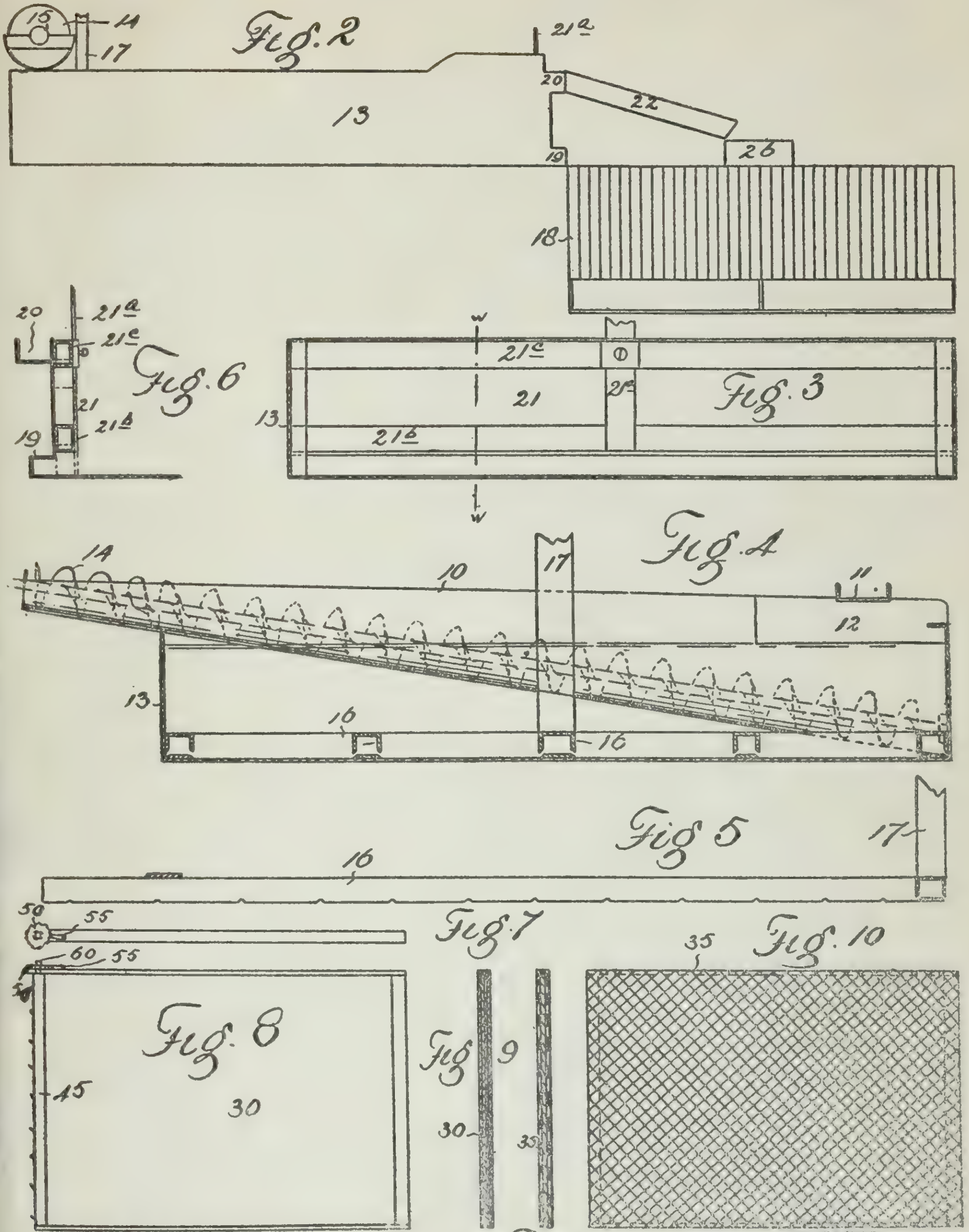
ATTORNEY.

(No Model.) 3 Sheets—Sheet 2.

E. A. HOCKLEY.

ORE SLIMER.

No. 466,753. Patented Jan. 5, 1892.



WITNESSES:

Louis E. P. Wilkes
Wm. McConnell

INVENTOR

Edgar A. Hockley

BY A. J. O'Brien

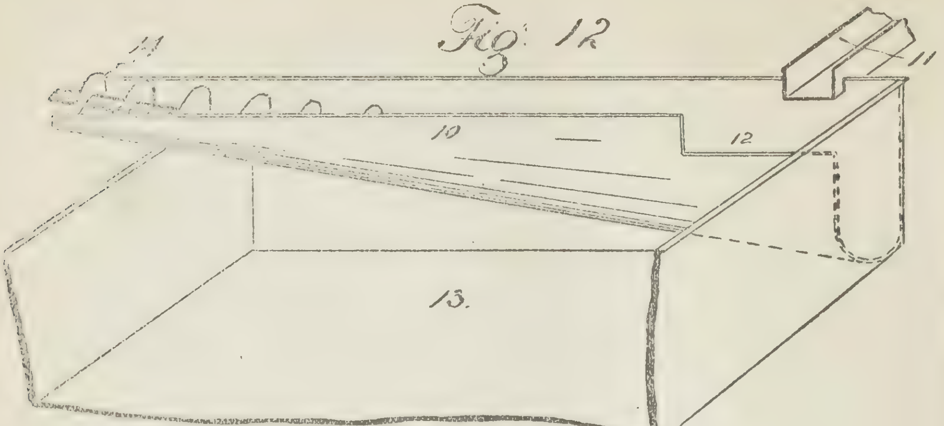
ATTORNEY.

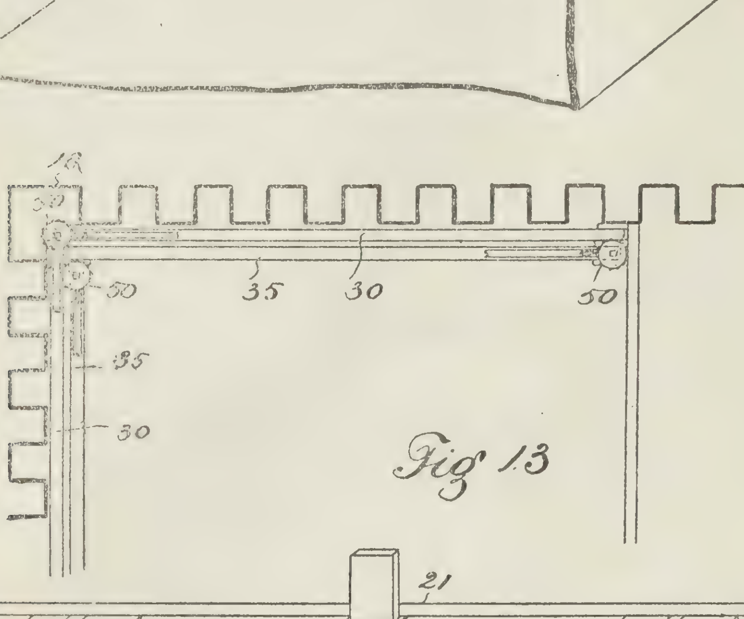
(No Model.) 3 Sheets—Sheet 3

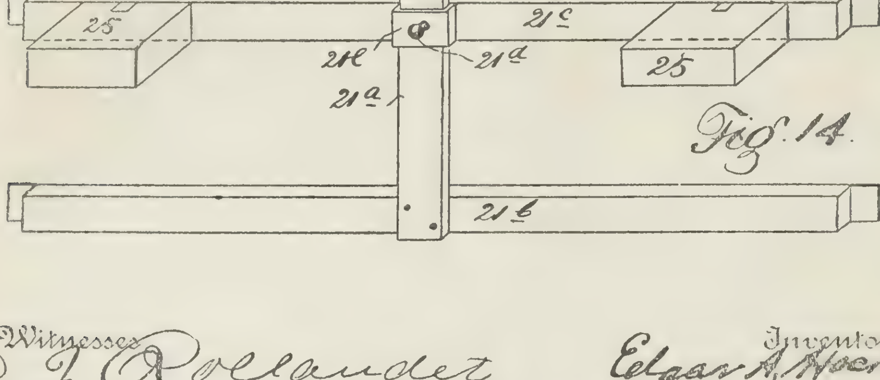
E. A. HOCKLEY

ORE SLIMER.

No. 466,753 Patented Jan. 5, 1892.







Witnesses
C. J. Rollandet
Wm. McConnell

Inventor
Edgar A. Hockley
By his Attorney
A. J. O'Brien

UNITED STATES PATENT OFFICE.

EDGAR A. HOCKLEY, OF OURAY, COLORADO.

ORE-SLIMER.

SPECIFICATION forming part of Letters Patent No. 466,753, dated January 5, 1892.

Application filed May 19, 1891. Serial No. 393,346. (No model.)

To all whom it may concern:

Be it known that I, EDGAR A. HOCKLEY, a citizen of the United States of America, residing at Ouray, in the county of Ouray and State of Colorado, have invented certain new and useful Improvements in Ore-Slimers; and I do declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to the figures of reference marked thereon, which form a part of this specification.

My invention relates to a novel form and construction of mechanism for treating ores, and is designed to save the float mineral, usually called "slimes" and sometimes termed "flour" gold and silver. Whichever term may be employed the meaning is the same to practical miners and to those skilled in the art to which this invention appertains, since these terms are applied to that portion of the mineral which is too light to be saved by the ordinary gravity processes, which depend upon the greater specific gravity of the mineral, which causes the same to settle and separate from the gangue or lighter portion of the material. In all classes of ore there is more or less of this light flour or float mineral, which is held in suspension by the water, while in some kinds of ore this class of mineral amounts to a very large proportion of the value, which is therefore ordinarily lost or carried to the dump with the so-called "tailings."

The object of this invention therefore is to save this light mineral either by the original treatment of the ore or by retreating the tailings which have passed through other machines.

The principle of the invention is to aid or increase the natural floating tendency or buoyant condition of the mineral particles, whereby the valuable portion is made to float, while the gangue, which is heavier, settles, thus effecting the separation.

My improved mechanism consists of a pulp-box, a separator, and a filtering-tank. The material to be treated is first discharged into the pulp-box, which catches the greater part of the gangue, and is provided with a screw conveyer for removing the same as fast as it settles, the lighter and valuable portion of the mineral passing thence into the separator, into the bottom of which is forced air, steam, water, or other suitable material, producing such an agitation at the bottom as will cause the mineral to float after first separating or washing it from the gangue, when it passes into a filtering-tank, in which the water is drawn off by suitable means, leaving the mineral. This mechanism will be better understood by reference to the accompanying drawings, in which is illustrated an embodiment of the invention.

In the drawings, Figure 1 is a top or plan view of the mechanism; Fig. 2, a side view or elevation of the same; Fig. 3, a section on the line *y y*, Fig. 1; Fig. 4, a section on the line *x x*, Fig. 1; Fig. 5, a section on the line *z z*, Fig. 1; Fig. 6, a section on the line *w w*, Fig. 3; Figs. 7 and 8, a top and side view, respectively, of the outer filter; and Fig. 9 a section of the same. Figs. 10 and 11 are a side view and a section, respectively, of the inner filter. Fig. 12 is a perspective view of the pulp-box, showing its connection with the separator-tank, which is partially broken away. Fig. 13 is a top fragmentary view, on an enlarged scale, of the filtering-tank, showing the filtering-walls and the rollers to which they are attached. Fig. 14 is a perspective view of the gate which controls the discharge of the material from the separating-tank.

In the views, wherein similar reference-characters designate corresponding parts or elements of the mechanism, let the numeral 10 designate the pulp-box into which the material to be treated is discharged through chute or spout 11. Enough water is discharged into the box 10 with the ore to float the light and valuable portion of the same, which float material or scum passes through a suitable opening 12 into the separating-tank 13, while the gangue or worthless portion passes to the bottom of the box 10, which is provided with an inclined conveying Archimedean screw 14 for removing the gangue from this box. The bottom of this box is inclined correspondingly with the inclination of the screw. The lower end of this screw is journaled in the receiving extremity of the box, whence the gangue is carried upward the entire length thereof, the inclination of this screw and the bottom

of the box being such that the gangue is above the water-level before it is discharged therefrom. The upper extremity of the screw shaft is journaled in a suitable support and is provided with a pulley 15, by means of which motion may be communicated to the screw from any suitable motor. The screw being in motion, the material in box 10 is kept in a state of continuous agitation, so that as the gangue passes upward toward the discharge extremity of the box the float mineral is washed therefrom and rises to the top in a scum, which passes thence to the separator, as before stated. The size and location of the screw are such that its threads reach close to the sides and bottom of the box, by which it is enabled to remove the material very clean from the box. A considerable portion of the gangue which is more closely associated with the mineral will find its way to the separator, which consists of a tank of any desired capacity, preferably located contiguous to the pulp-box. In the bottom of this separator is located a series of perforated tubes or conduits 16, all communicating with each other and forming in effect one continuous perforated conduit. One branch of this conduit is in communication with a stand-pipe or upright tube 17, through which air, water, steam, &c., may be forced into tubes 16 and thence into the bottom of the tank for the purpose of agitation, whereby the light mineral is washed or separated from the heavier gangue and an increased upward or buoyant tendency given said mineral, keeping the same upon the surface of the water until discharged into the filtering-tank 18, hereinafter described. At the bottom of the discharge end or sides of the tank is located the lower trough 19 for carrying away the gangue which settles in the bottom of the tank and the upper trough 20, into which the float mineral passes, which collects in the form of a scum upon the surface of the water. The discharge into the troughs 19 and 20 is controlled by the gate 21, consisting of a stem or standard 21^a, centrally located, a lower valve 21^b, rigidly secured to the stem, and an upper valve 21^c, adjustable thereon by means of a set-screw 21^d, which passes through a metal strap 21^e, secured to the valve and through which the stem passes. The valves are simply cross bars or slats centrally connected with the stem and having their extremities guided in grooved ways 40, formed in the sides of the tank. The gate is also provided with one or more floats 25, preferably two, as shown in the drawings. The floats are secured to the upper or adjustable valve in any suitable manner and are designed to rest upon the surface of the water and to regulate the gate automatically and maintain a uniform quantity of water in the separating-tank. For instance, when the proper amount of water is in the tank valve 21^c, with its floats, is set at the proper height—that is, with the floats resting upon the surface of the water—valve 21^b being partly opened or sufficiently so to carry off the surplus-water supply, or that which enters with the material treated. Then if the water-supply is increased the floats will rise and increase the opening below valve 21^b, so as to carry away this increased or excessive supply, while as soon as the supply is diminished the floats lower and partially close valve 21^b. It will thus be seen that this gate is capable of such adjustment that the proper level of the water in the separating-tank may be automatically maintained.

The water and gangue passing through trough 19 may, if desired, be carried or drawn off into any suitable receptacle, whereby they may be allowed to settle in the ordinary way, while the floats or slimes passing into trough 20 are carried by a conduit 22 to the filtering-tank 18. As shown in the drawings, this tank is divided into four compartments by suitable partitions 18^a, which at their intersections in the center of the tank support a box or receptacle 26, into which the material is discharged directly from conduit 22. Receptacle 26 is provided with openings 26^a, adapted to distribute its contents equally into the compartments of the filtering-tank. It will be observed that the dividing of this tank into compartments is only for convenience and not an essential feature, since it may consist of a single compartment or a plural number, as may be desired. The outer walls of this tank 18 are corrugated, as shown in the drawings, but may be of any construction adapted to permit the escape of the water after having passed through the inner filtering-walls of the tank. The filtering-walls are double and consist of an outer wall 30 and an inner wall 35. These walls 30 and 35 are preferably formed in sections adapted to slide in grooved ways or guides secured to or formed within the outer walls of the tank. The filtering-walls are constructed in any suitable manner, the outer being the finer mesh. A suitable construction for the inner wall 35 is a sheet of asbestus paper placed between two sheets of wire-cloth. The asbestus forms the filter, while the wire-cloth gives it protection and support. The whole is attached to a skeleton frame of suitable strength and composed of any desired material. The outer wall 30 may be composed of filtering-paper secured between two layers of cloth attached to a suitable frame. This cloth is preferably made stationary at one end of the frame and secured to an adjustable roller at the other end. This roller is provided with hooks, to which the cloth may be secured, while the top of the roller is provided with a small ratchet-wheel 50, the teeth of which are engaged by a pawl or dog 55, secured to the upper stationary cross-bar of the frame. It will thus be seen that by placing a suitable crank upon the upper extremity 60 of the roller and turning the same the tension of the cloth forming part of the filter may be adjusted to suit the purpose or the requirements of the case. It

..ill thus be seen that by this construction the mineral will be retained in the tank, while the water is allowed to escape In cleaning up a portion of this mineral will be found between the filters. This may, however, be easily removed by raising the inner filter and brushing this mineral out into the tank.

Having thus described my invention, what I claim is—

1. In an ore separator or slimer, the combination, with a receiving-box provided with an inclined screw conveyer, of a separating-tank provided with perforated tubes located in the bottom or lower portion thereof, a stand-pipe connected with said tubes, a bottom discharge-opening for the tank, and a vertically-movable gate automatically regulated by means of floats, whereby said discharge-opening is controlled, substantially as described.

2. A tank provided with filtering-walls supported upon suitable frames provided with rollers, the filtering material being made fast to the frame at one extremity and to the roller at the opposite extremity, whereby its tension may be regulated as desired, the roller being provided with suitable locking mechanism, as set forth.

3. A tank provided with double filtering-walls of unequal mesh, each wall being supported upon a frame provided with an adjusting-roller, to which the filtering material is attached at one end, substantially as described.

4. A tank provided with removable filtering-walls, each wall consisting of a frame provided with a roller, and a strip of suitable filtering material made fast to the frame at one extremity and to the roller at the opposite extremity, whereby the tension of the filter may be regulated at will, as set forth.

5. A separator provided with perforated tubes located in the bottom or lower portion of the tank and communicating with each other, a stand-pipe leading to the tubes, a bottom discharge-opening, and a gate provided with floats, whereby said opening is automatically regulated, substantially as set forth.

6. A filtering-tank provided with outer corrugated walls and inner removable filtering-walls provided with rollers for regulating the tension of the filtering material, as set forth.

7. An ore separator or slimer consisting of a receiving-tank provided with an inclined screw conveyer, a separating-tank provided with perforated pipes located at or near its bottom and a stand-pipe connected therewith, said tank being provided with a top and bottom discharge, a vertically-movable gate provided with valves and floats, whereby the discharge of material from the tank is automatically regulated, and a suitable filtering-tank, the three tanks being arranged and connected substantially as and for the purpose set forth.

In testimony whereof I affix my signature in presence of witnesses.

EDGAR A. HOCKLEY.

Witnesses:

W. H. GUBBERT,

L. C. KIMBLE,

W. B. VANATTA.

(No Model.)

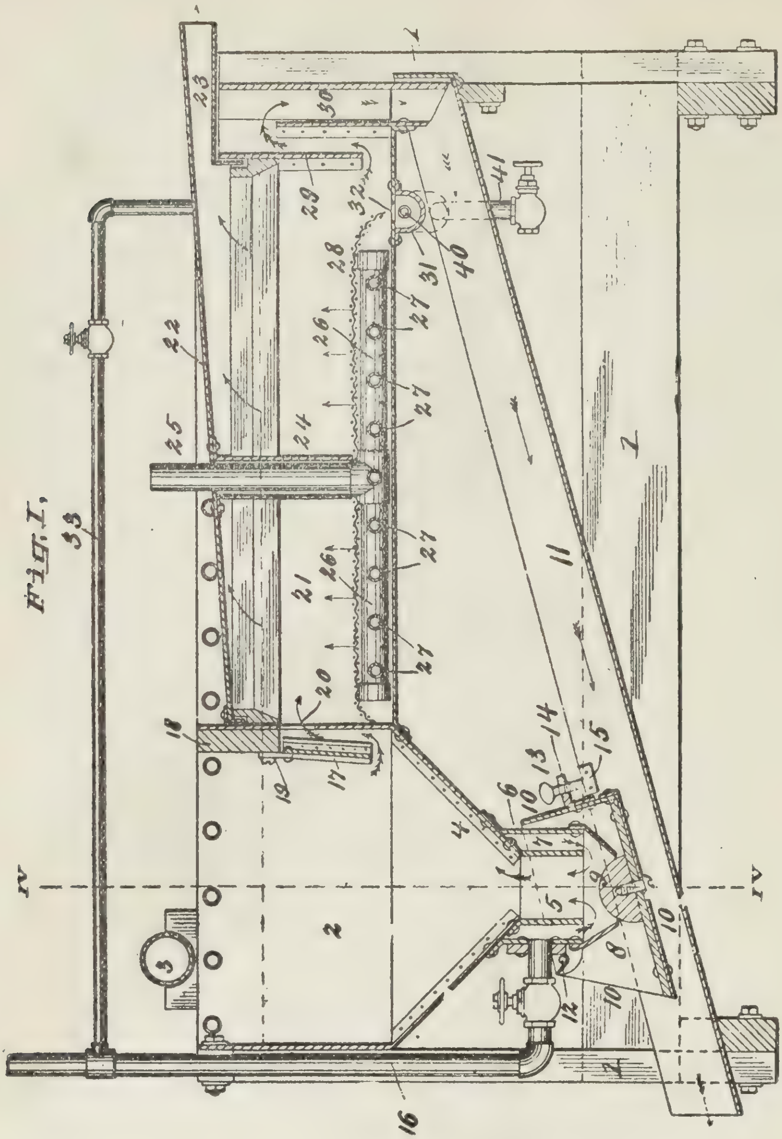
3 Sheets—Sheet 1

A. M. ROUSE.

METHOD OF AND APPARATUS FOR SEPARATING SLIME OR FINES FROM WATER USED IN MILLING ORES.

No. 469,599

Patented Feb. 23, 1892.



ATTEST

M. E. Durand

S Cotton

INVENTOR

Albion M Rouse

By Knight & Bro

Attys

(No Model.) 3 Sheets—Sheet 2

A. M. ROUSE.

METHOD OF AND APPARATUS FOR SEPARATING SLIME OR FINES FROM WATER USED IN MILLING ORES.

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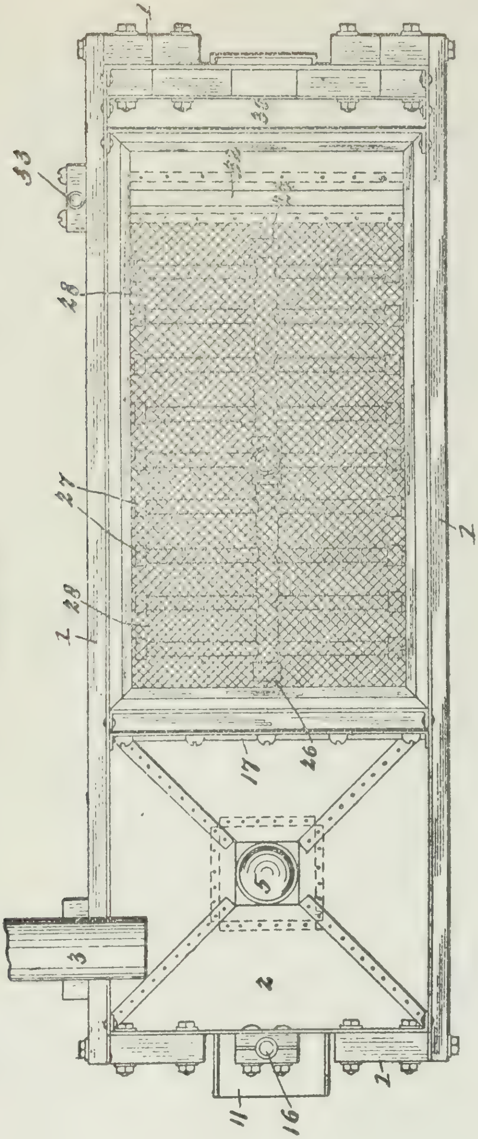
Fig. II.



ATTEST

M. E. Durand
S. Cotton

INVENTOR
Albion M. Rouse
By Wright Bros
Attys

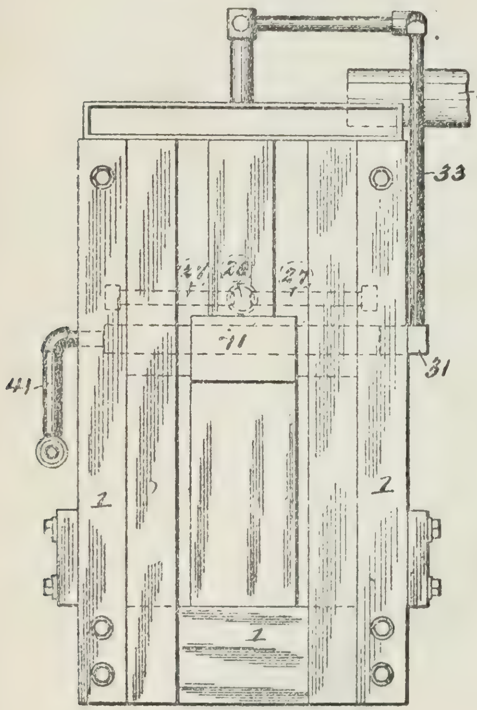
(No Model.) 3 Sheets—Sheet 3.

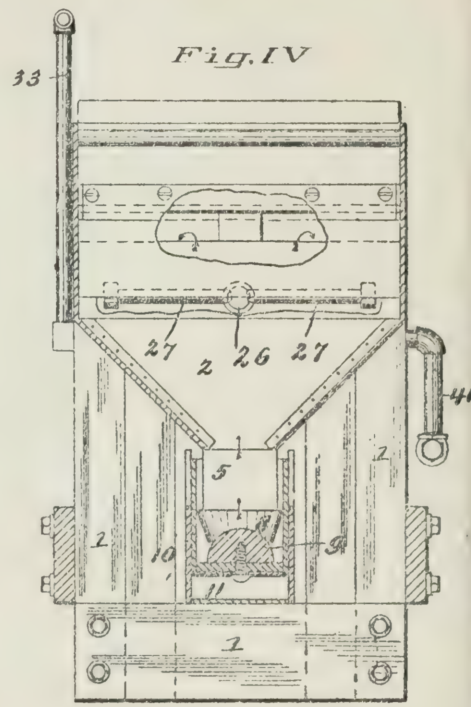
A. M. ROUSE.

METHOD OF AND APPARATUS FOR SEPARATING SLIME OR FINES FROM WATER USED IN MILLING ORES.

No. 469,599. Patented Feb. 23, 1892.

Fig. III.





ATTEST
M. E. Durand
S. Cotton

INVENTOR
Albion M. Rouse
By Knight Bros
Attys

UNITED STATES PATENT OFFICE.

ALBION M. ROUSE, OF BOULDER, COLORADO, ASSIGNOR TO GEORGE R. WILLIAMSON, OF SAME PLACE.

METHOD OF AND APPARATUS FOR SEPARATING SLIME OR FINES FROM WATER USED IN MILLING ORES

SPECIFICATION forming part of Letters Patent No. 469,599, dated February 23, 1892.

Application filed September 29, 1891. Serial No. 407,147. (No model.)

To all whom it may concern:

Be it known that I, ALBION M. ROUSE, of the city of Boulder and county of Boulder, in the State of Colorado, have invented a certain new and useful Improvement in Methods and Apparatus for Separating Slime or Fines from Water Used in Milling Ores, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming part of this specification.

My invention relates to an improved method and apparatus for removing or separating slime or fines from water carrying ores; and my invention consists in features of novelty hereinafter fully described, and pointed out in the claims.

Figure I is a vertical longitudinal section of an apparatus embodying my invention. Fig. II is a top or plan view with the cover of the scum-chamber removed. Fig. III is an end view, and Fig. IV is a vertical transverse section taken on line IV IV Fig. I.

I will proceed to describe the apparatus with reference to the drawings, which, with the description of the operation of the apparatus, will explain my improved method.

1 represents a suitable frame.

2 represents a pulp-chamber, into which the pipe 3 discharges the tailings from an ore-mill. This chamber has a funnel-shaped bottom 4, terminating in a neck 5, surrounded by a cylinder or wall 6, forming an annular chamber 7. The lower end of the cylinder or annular wall 6 forms the seat 8 of a valve 9, secured to a housing 10, located in a trough 11 and pivoted to the frame at 12. The valve 9 is moved to or from its seat by a set-screw 13, passing through a lug 14 on the housing and bearing at its lower end against a cross-piece 15 on the trough 11, so that by turning the set-screw the valve may be moved to or from its seat by adjusting the housing on its pivot 12.

16 represents a water-pipe discharging into the chamber 7.

17 represents a yielding gate secured to a cross-piece 18 of the frame 19 and behind which there is an opening 20 in the inner wall of the chamber 2.

21 represents the slime-chamber having a cover 22 with a discharge-spout 23. The cover 22 has a sleeve 24, which extends downward through the chamber 21 and receives the vertical portion 25 of an air-pipe, on the lower end of which are horizontal pipes 26, having a number of perforated lateral pipes 27.

28 represents a perforated metal or wire mesh screen located over the pipes 26 27.

29 represents a deflecting-plate at the inner end of the chamber 21 and behind which the waste water passes into a spout 30, which discharges into a trough 11.

31 represents a trough on the under side of the bottom of the chamber 21 and which communicates with the chamber through an opening 32.

33 represents a pipe forming a communication between the pipe 16 and the trough 31, through which water is discharged into the trough to remove the particles which may fall into the trough through the opening 32.

40 is a jet flushing-pipe in the trough 31 to promote action of the parts precipitated. 41 is a discharge-pipe from the trough 31.

The operation of the device or apparatus is as follows: The mill-tailings drop from the pipe 3 into the chamber 2. Water from the pipe 16 enters the chamber 7, the greater portion of it passing up through the neck 5 into the chamber 2, as shown by the arrows, while a smaller portion passes around the valve 9 and escapes into the trough 11. The up-current is rapid enough to prevent the descent of the slime-water in chamber 2 and carries the slime-water up behind the gate 17 through the opening 20 into the chamber 21 and along the chamber over the pipes 26 27. The waste water then passes up behind the deflector 29 into the spout 30 and is discharged through the trough 11 to the dump. As the slime-water passes slowly through the chamber 21 it is acted upon by an innumerable number of air-bubbles escaping from the perforate pipes 26 27, into which the air is forced through pipe 25. The constant upward circulation of air through the slime-water tends to elevate all foreign matter to the surface of the water and to create or form a mass of strong foam having a great carrying energy for matter foreign to water. As the foam accumulates in the chamber 21 it is forced out through the passage 23 to a drier.

By means of this invention valuable min-

eral slime or fines may be saved which have heretofore been lost.

I claim as my invention—

1. The improved method of separating mineral slime or fines, consisting in discharging air beneath the body of slime and causing it to be emitted and permitted to pass upward through the slime, forming a foam, substantially as set forth.

2. The improved method herein shown and described, consisting in depositing the mill-tailings into a receptacle through which there is an upward flow of water, then carrying the water and tailings through a chamber, and causing an upward flow of air through the body of water and tailings, forming a scum, substantially as and for the purpose set forth.

3. The combination of the chambers 2 and 21, an air-pipe 25, having perforated branches for the escape of air, a screen over said branches, and a separate escape for the waste water and scum formed by the passage of the air through the mass, substantially as and for the purpose set forth.

4. The combination of the chamber 2, having a neck 5, a wall 6, forming a chamber 7, the valve 9, secured to an adjustable housing 10, the pipe 16, the gate 17, a chamber 21, having a cover 22, a pipe 25, having perforated branches, a screen 28, a trough 31, communicating with the chamber 21, pipes for cleaning the trough, a deflector 29, spouts 23 and 30 and a trough 11, substantially as and for the purpose set forth.

ALBION M. ROUSE.

In presence of—

JOHN P. HALDEMAN,

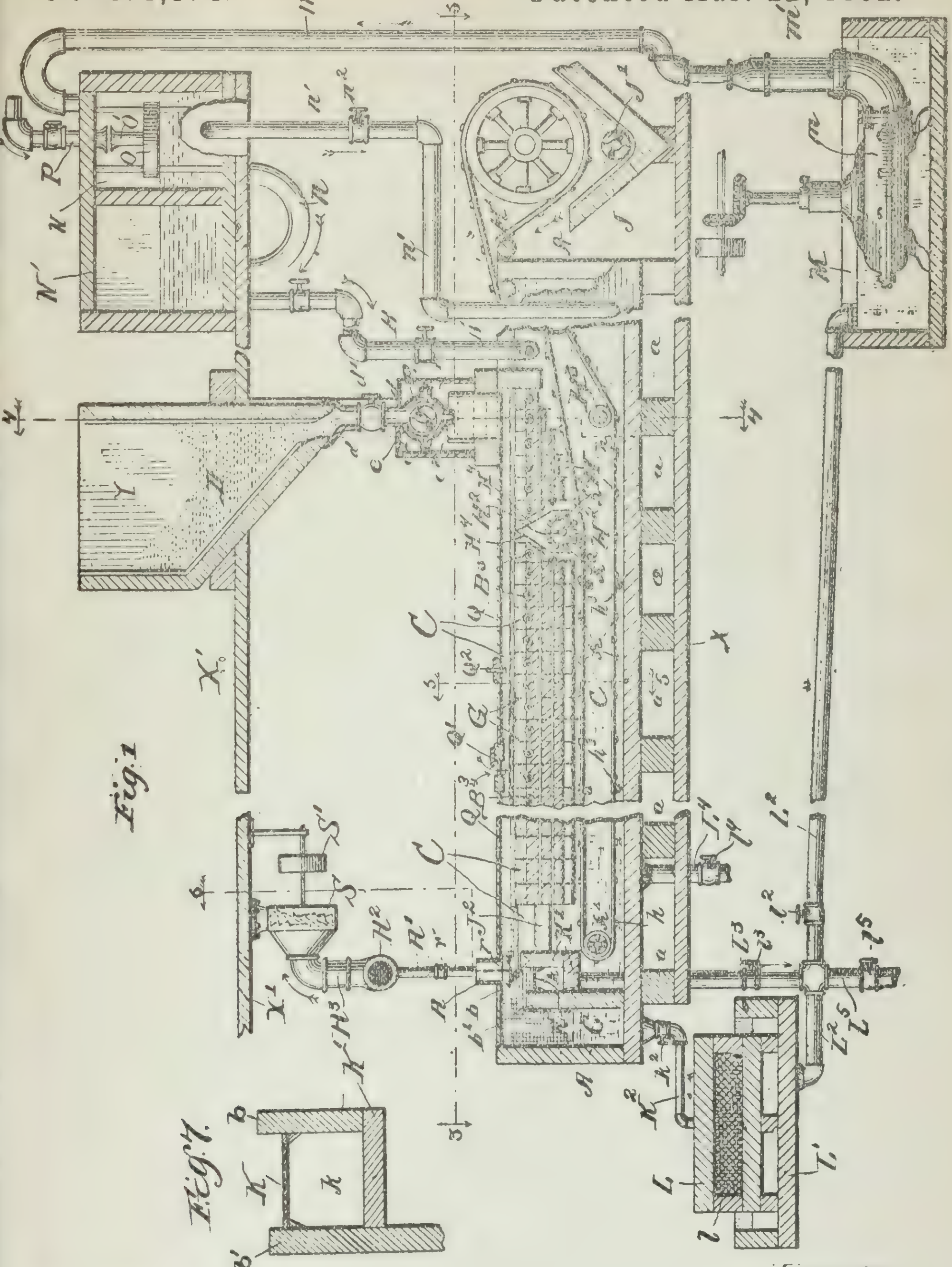
C. C. HALDEMAN.

(No Model.) 3 Sheets—Sheet 1

C. B. HEBRON & C. J. EVERSON.

PROCESS OF CONCENTRATING ORES.

No. 471,174. Patented Mar. 22, 1892.



Witnesses;
Lute S Alter
Flora L. Brown

Inventors:
Charles B. Hebron
and Carrie J. Everson
By Charles T. Brown, Atty

(No Model.) 3 Sheets—Sheet 2.

C. B. HEBRON & C. J. EVERSON.

PROCESS OF CONCENTRATING ORES.

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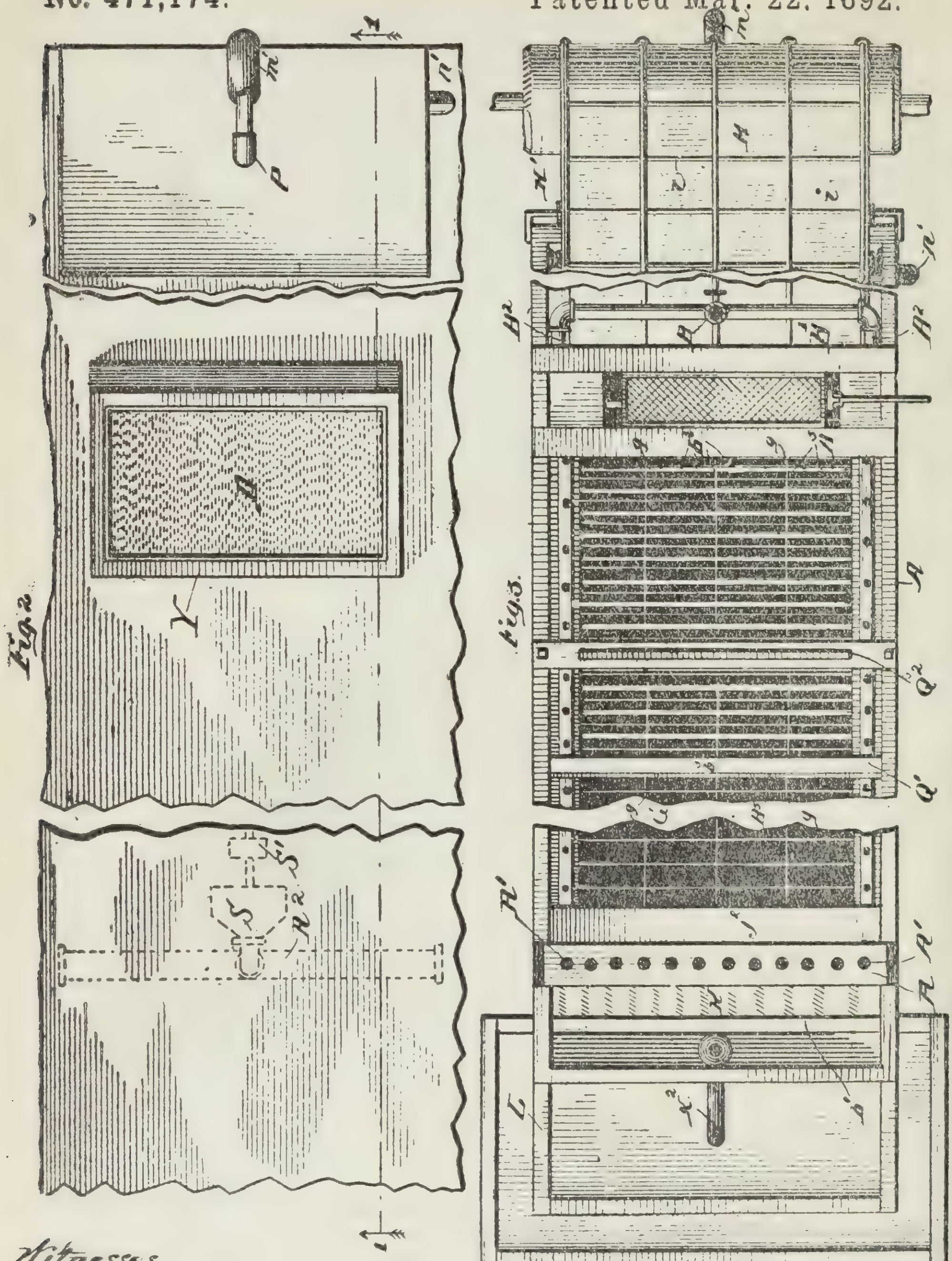

Witnesses,
Leete S. Alter
Flora L. Brown

Inventors,
Charles B. Hebron and
Carrie J. Everson
By Charles T. Brown, Atty

(No Model.) 3 Sheets—Sheet 3.

C. B. HEBRON & C. J. EVERSON.

PROCESS OF CONCENTRATING ORES.

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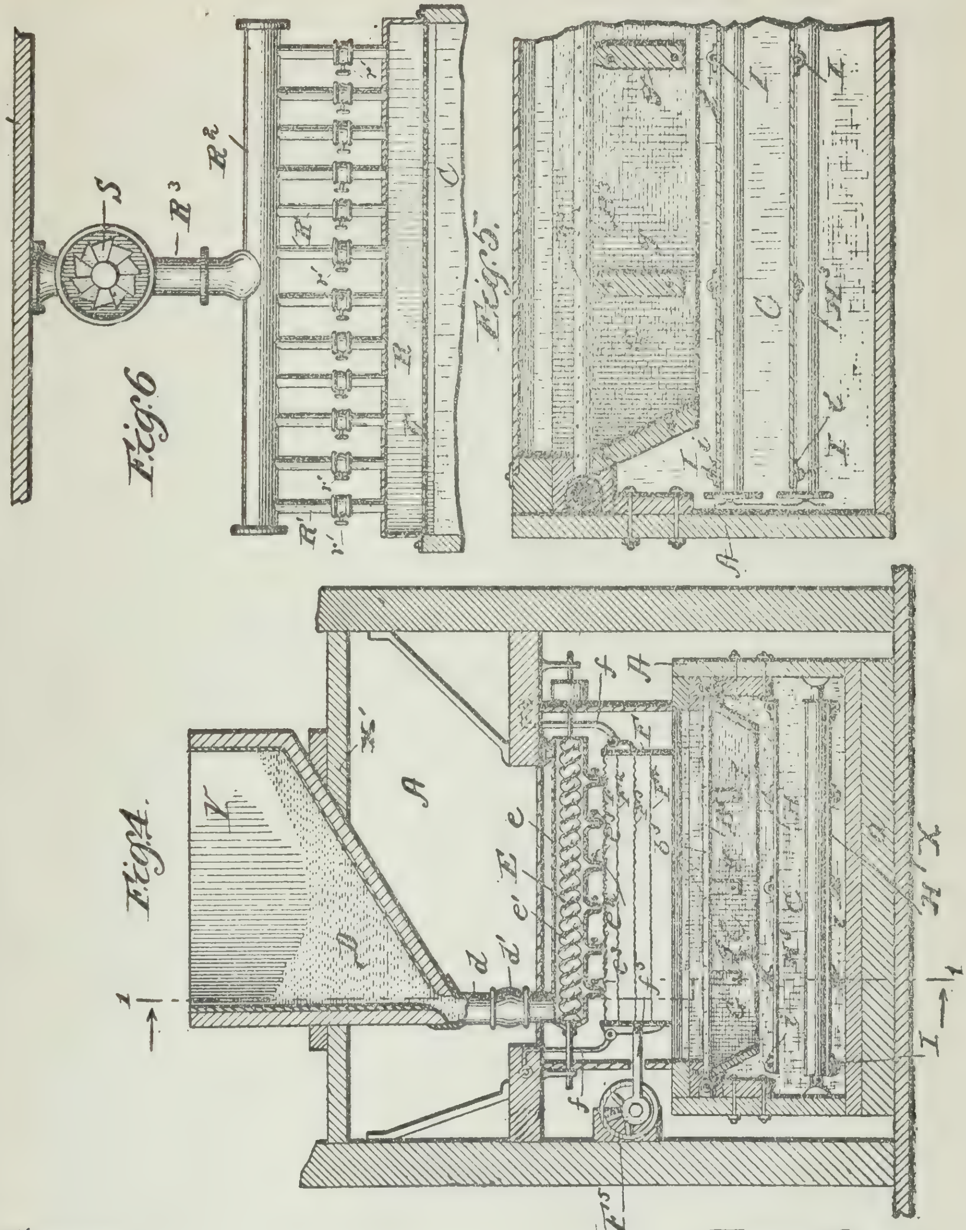


Witnesses;
Lute S. Alter
Flora L. Brown.

Inventors.
Charles B. Hebron
and Carrie J. Everson.
By Charles T. Brown,
Atty.

UNITED STATES PATENT OFFICE.

CHARLES B. HEBRON AND CARRIE J. EVERSON, OF DENVER, COLORADO

PROCESS OF CONCENTRATING ORES.

SPECIFICATION forming part of Letters Patent No. 471,174, dated March 22, 1892.

Application filed September 1, 1891. Serial No. 404,400. (No model.)

To all whom it may concern:

Be it known that we, CHARLES B. HEBRON and CARRIE J. EVERSON, both residents of Denver, in the county of Arapahoe and State of Colorado, have made new and useful Improvements in Processes for the Concentration of Certain Ores; and we do declare the following to be a full, clear, and exact description of the invention, such as will enable those skilled in the art to which it appertains to practice the same.

Our invention relates to the concentration of ores, and has for its object the successful and economical separation of the lighter metals and minerals from their associate rock, many of which have never heretofore been successfully separated by mechanical processes—that is, processes wherein the relative specific gravity of the ore values, the rock-matrix of the ore, and the suspensive fluid in which the separation has been attempted have been relied upon for effecting by means of many different mechanical appliances the desired separation of such values from the rock-matrix of the ore.

The failures resulting from the heretofore-known processes may be briefly stated to be due to the effort of inventors of mechanical processes and builders of ore-separators to obtain the desired concentration with processes and machines based upon the theory contained in the statement by text authorities that all metals and minerals are of greater specific gravity than the rock portion of their respective ores, such statement being misleading and untrue because of the porosity of structure and irregularity of form which exists in metallic and mineral particles contained in certain ores whereof the rock-matrix is crystalline, such rock particles having smooth and glassy surfaces, as we have discovered by an extended series of microscopical examinations, wherein the ore examined has been first pulverized to a degree of fineness permitting it to pass through the meshes of a series of Swiss bolting-cloth screens of a mesh varying from one hundred to one hundred and eighty meshes per linear inch and then examining the mineral, metallic, and rock particles of the ore with a microscope producing an enlargement of at least three thousand diameters, and the process embodying our invention has particular reference to the separation or concentration of such ores.

The form and structure of the mineral and metallic particles adapted when contained in a suitable crystalline rock-matrix to be separated by our process is amply illustrated and particularly noticeable in bismuth, silver, copper carbonate, silver chloride, gray copper, ruby silver, tellurides, copper and silver glances, as well as other forms of black sulphurets, wire silver, nearly all native silver, flake and flour gold, and frequently coarser particles of free gold, such mineral and metallic particles being irregular in form, with cavities or depressions on the surfaces thereof, and porous in structure, frequently resembling in appearance coral or sponge or vegetable fibers, as sprigs of moss or segments of fronds. Further, there is a type of ores made up of an argentiferous class of minerals associated with a tough crystalline rock, especially noticeable in spar-gangue carrying gray copper, in which the mineral does not exist in minute particles or in intimate dissemination through the rock, but in coarse particles widely separated from each other and of an extremely rigid though friable texture, for the concentration of which our process is well adapted. In the operation of pulverizing this ore sufficiently to liberate the mineral contained therein, though only a coarse pulverization is required, the mineral becomes reduced to an almost impalpable slime, the particles thereof being sufficiently fine for the requirements of this process. We have also discovered that the buoyancy of the above-named minerals and metallic particles or the tendency of such particles to remain suspended in fluid may be so increased by applying thereto properly-prepared buoyant material in a suitable way and under such pressure as to cause particles thereof to adhere to the irregular surfaces and to be contained or pressed into the cavities or pores of such mineral and metallic particles that they will not only remain suspended in fluid for much longer time than would the mineral and metallic particles when not joined to particles of buoyant material, but also to float upon the surface of liquid for a sufficient time to be separated from the rock-matrix of the ore

by such rock-matrix settling through such liquid. In practicing this invention such properly-prepared buoyant material is evenly distributed with the ore particles by means of shaking or revolving screens or of equivalent mechanical devices, and the mixture so obtained is then submitted to a rubbing movement and pressure, the result being that the particles of buoyant material are pressed into the cavities and pores, or partially so, of the mineral and metallic particles and made to adhere to the rough and irregular surfaces thereof, and they (the joined mineral and metallic particles of the ore and buoyant material) are of less specific gravity for a time than the rock particles of such ore.

We have found ordinary mill-burrs to be effective in the operation of attaching the particles of buoyant material to the metallic and mineral particles of disintegrated ore.

The amount of bouyant material to be added to a given quantity of pulverized ore must be determined by the bulk of the metal or mineral contained in such ore. Experience has shown us that if the amount of foreign buoyant material added to the disintegrated ore be equal to or slightly in excess of the bulk of metal or mineral contained in such ore a sufficient buoyancy will thereby be imparted to the metal and mineral particles after thus joining to admit of their obtaining the upper strata when such prepared ore-stock is submitted to stratifying agencies.

The following list comprises a number of materials which are typical of the substances that may be employed to render metallic and mineral particles buoyant: Charcoal, coke, lamp-black, plumbago, any of the friable vegetable fibers—such as bark, moss, straw, cotton, wool—also sulphur, (sublimed,) aluminum trihydrate, hydrated lime sulphate, sodium oleate and other cheap salts of sodium, also the cheap metallic sulphates and oleates. These salts must be dry not only in the ordinary sense, but entirely dehydrated, so as to render them amorphous. The carbonaceous substances are first named because of their cheapness, their positiveness of action, and their destructibility in the furnace. Sulphur also acts as a fuel and in the free state and proper quantity for carrying out the process would be unobjectionable to the smelter. Lime salts acting as oxidizing fluxes need no consideration, nor do the soluble salts, as they are easily removed from the concentrates before smelting. In operating with soluble salts the water employed in the separator-tank, hereinafter described, must be saturated either with the same salt or with one which will preserve the same conditions—that is, remain incapable of dissolving or reacting chemically upon the salt mixed with the ore and attached to the metallic and mineral particles thereof. To this rule we make certain exceptions—to wit, cases where the newly-formed substance is able to take the place of the one destroyed, as in the case of sodium oleate reacting to form oleic acid or any other oleate or in the case of common alum acting to form aluminium hydrate.

The terms "oleic acid" and "oleate" are here used to embrace the mixed fatty acids and their salts resulting from the decomposition of commercial soaps.

The degree of fineness to which the ore must necessarily be pulverized before the "buoy-stock" (as we shall hereinafter term the buoyant material) is joined thereto is determined by the character of the ore and the manner in which the mineral and metallic particles are disseminated in the rock-matrix of the ore.

While some of the lighter class minerals are found sparsely and intimately disseminated with the rock-matrix of their respective ores and the particles of minerals so minute as to require a pulverization which is commercially impracticable, yet in nearly all cases where the metallic and mineral particles are found in a crystalline rock-matrix constituting an ore otherwise suitable for separation by our process we have found that a pulverization of from ninety to one hundred and sixty mesh, such pulverization being eminently practicable, effectually pulverizes the ore to a degree of fineness which liberates the values from their envelopment.

In cases where vegetable fiber or any of the carbonaceous substances are used as a buoy-stock they, together with the disintegrated ore, must be dry before the two are mixed preparatory to the joining of the metallic and mineral particles to and with the buoy-stock. In cases where the chemically-prepared buoy-stock is used the ore and the buoy-stock may be mixed or distributed together in the presence of moisture; but the operation of attaching the buoyant material to the metallic and mineral particles of the ore must be performed after the entire mass thus distributed together has been thoroughly dried.

As our process is only adapted to separate the metallic and mineral particles from a crystalline rock, (an ore with a rock matrix of crystals, as a pure and translucent quartz, or a crystalline spar-gangue being particularly favorable,) no trouble arises in attaching the buoyant material to the metallic and mineral particles of the pulverized ore from any tendency of the buoyant material to adhere to the surface of the rock particles, as the faces of the rock particles are smooth and glassy and offer no position of lodgement for such buoyant material.

We do not claim any value for this process if it be applied to an ore with a talc or clayey gangue, or, except for the separation of the lighter mineral and metallic particles, when applied to an ore containing galena or pyrites of cubical formation.

When ores adapted for treatment by this process are prepared in the foregoing man-

ner, a separation may be effected with more or less perfection if the thus-prepared stock be submitted to any of the standard dry or wet concentrators. In case a dry separator be used the buoyed values of the ore-stock will attain the position reached by the gangue when the conventionally-prepared ore-stock is put in the machine, and the rock particles will be delivered to the position that the product is delivered in such cases, and if the ore-stock prepared by our method is delivered by means of sifting or blowing to the surface of the water contained in or upon wet concentrators the reverse of position to that of the product and waste of the ordinarily-prepared ore-stock in the use of the machine is attained by the product and the waste. Repeated experiments have proven to us that the standard concentrators in use—such as air-jigs, oscillating tables, wet jigs, frue vanners, or percussion-tables—may be adjusted to admit of a fairly good separation; but there are mechanical barriers to the perfect separation, or, more particularly, to the rapid and economical operation of the same. Therefore we submit a description of a device, the invention of Charles B. Hebron, peculiarly suited to the successful operation of separating the buoyed values from the rock particles of the ore-stock as prepared in the hereinbefore-described manner and an illustration of such device in the drawings accompanying and forming a part of this specification, in which—

Figure 1 is a longitudinal sectional view of a liquid-separator on line 1 1 of Fig. 2, viewed in the direction indicated by the arrows; Fig. 2, a plan view; Fig. 3, a horizontal sectional view on line 3 3 of Fig. 1, viewed in the direction indicated by the arrows, the top of the tank of the separator being transparent and so exposing to view the several parts contained in the tank; Fig. 4, a vertical cross-section on line 4 4 of Fig. 1, viewed in the direction indicated by the arrows; Fig. 5, a vertical cross-section, on an enlarged scale, of a portion of the device on line 5 5 of Fig. 1, viewed in the direction indicated by the arrows; Fig. 6, a vertical cross-section on line 6 6, Fig. 1, also viewed in the direction indicated by the arrows; and Fig. 7, a detail view of the foraminated plate (illustrated in Fig. 1) near the tail end of the tank of the separator, and hereinafter termed a "perforated table."

The same letter of reference is used to indicate a given part where more than one view thereof is shown.

X X′ are floors of the building in which the separator is placed.

Y is the storage for the ore-stock which is to be run through the separator.

A is a tank adapted to hold liquid, constructed of any suitable material, but preferably of wood, and rectangular in shape, with its greatest length from the head to the tail.

a a are timbers resting on the floor X, extending transversely across between the tank A and the floor X, on which timbers the tank rests.

The liquid contained in the tank, preferably water or brine—that is, water saturated with common salt—is supplied thereto through the pipe B at the head end of the tank and is ultimately discharged over the bridge walls or partitions *b b′* at the tail end of the tank. Such liquid is lettered C. The pipe B extends downward to underneath the surface of the liquid C in the tank and at its lower end is connected with a series of horizontal pipes consisting of transverse pipe B′, longitudinal pipe B^2, and smaller transverse pipes B^3 B^3.

b^3 b^3 are perforations on the upper half of each of the transverse pipes B^3 B^3, through which the liquid C enters the tank, there being sufficient head in the pipe B to force the liquid out of the perforations in a manner to produce a slight effervescing condition in such liquid directly over such perforations.

D is the ore-stock, properly prepared, contained in the storage Y.

d is a pipe having valve *d′* therein, extending from storage Y to transverse conveyer E. Conveyer E consists of tube or trough *e* and conveyer-screw *e′*, nipples e^2 e^2, extending downward from tube or trough *e*, and valves e^3 e^3 in such nipples.

e^4 is a driving-pulley on the shaft of the conveyer-screw by which such conveyer-screw is turned.

F is an oscillating frame suspended on vibratory arms *f f*, adapted to be rapidly moved a slight distance backward and forward or oscillated by the cam-wheel F^5 through connecting-arm f^5.

F′ F^2 F^3 F^4, respectively, are screens in frame F, forming a series of screens through which the ore-stock D, delivered from the nipples e^2 e^2 on the upper one thereof, passes just prior to its delivery to the surface of the liquid C in the tank A.

The purpose of the several mechanisms between the storage Y and the tank A is to insure the taking of the prepared ore-stock D from such storage and the delivery of the same to the surface of the liquid C in the form of a dust-cloud, whereby a thin surface charge of prepared ore-stock shall be obtained on the liquid C, near the head of the tank A, underneath the lower one of the screens forming the series. The ore-stock thus delivered to and contained on the surface of the liquid C in the tank A and consisting of the pulverized and buoyed values and the pulverized rock matrix or gangue are separated from each other in the tank, the purpose of the several mechanisms contained in the tank being to so separate the buoyed values in such ore-stock from the gangue thereof and to deliver such buoyed values at or near the tail end of the tank and to deliver the gangue of the ore-stock from the head end of the tank.

G G G are vertical partitions extending

transversely across the tank, the upper edge of each partition being a slight distance below the surface of the liquid C and the lower edge a short distance above an endless apron-belt, by which apron-belt the gangue settling through the liquid is carried from the tank.

g g are braces extending between partitions G G, respectively.

H is such endless apron-belt having taut cleats *h h h* thereon and longitudinal ropes I I fastened thereto by the straps *i i*, such straps being, preferably, sewed to the belt H. Apron-belt H extends longitudinally through the tank and out therefrom over the edge of the head end thereof, and from thence over the drum H′, by which drum it is moved.

The upper and carrying portion of the apron-belt H for the greater part of the length thereof is substantially horizontal, being held in position at the point of junction of the horizontal part extending along in the tank with the inclined part extending out of the tank over the edge of the head thereof by the sprocket-reel H^2, having projections h^2 h^2 thereon, and the horizontal position of the remainder of the carrying portion of the belt is obtained by such apron-belt extending around the roller or drum *h′* and idlers h^3 h^3. The lower or ingoing portion of the endless apron-belt is held in place by the roller or drum H^3. To prevent any possible disturbance of the surface of the liquid C by the movement of the sprocket-reel H^2 there is placed over it the housing H^4.

J is a spout or trough underneath the drum H′, adapted to receive the gangue delivered from the endless apron-belt H as such belt travels around the drum H′, and J′ is a common screw conveyer by which the spout or trough J is emptied.

J^2 is a horizontal planking forming a cover for the endless apron-belt at the tail end of the tank and also forming on the upper surface thereof a horizontal bed by which, from inspection of the settlings thereon, if any, the presence of gangue in the liquid about to pass over the bridge-wall *b* can be determined.

K is a perforated table forming a sieve, through which the greater part of the liquid passing over the bridge-wall *b* can pass into chamber *k*, such chamber *k* being formed by planking K′ and bridge-walls *b b′*. The liquid passing over the bridge-wall *b′*, carrying on the surface thereof the buoyed mineral and metallic particles from the ore-stock, flows through the pipe K^2 into receptacle L.

l l are screens in receptacle L, through which the liquid passing into such receptacle can pass into receptacle L′, thereby leaving the buoyed mineral and metallic particles in the receptacle L, from which they are taken to be afterward treated in any desired manner.

L^2 is a pipe extending from receptacle L′ to and communicating with receptacle M, and l^2 is a valve in pipe L^2.

L^3 is a pipe which extends from chamber *k* to pipe L^2 and is joined to pipe L^2 by means of a common T-joint, and pipe L^5 extends from pipe L^2, forming a continuation of pipe L^3.

l^5 is a valve in pipe L^5.

When valve l^2 in pipe L^2 or valve l^5 is open and valve l^3 in pipe L^3 is also open, the liquid in chamber *k* can pass therefrom through the pipe L^3. The proportion of the liquid passing over the screen K which is permitted to pass through such screen into chamber *k*, and from thence through pipe L^3, is determined by the valve l^3, and the direction such escaping liquid flows is determined by the valves l^2 and l^5, respectively—as, for instance, closing valve l^5 and opening valve l^2 guides the liquid into a receptacle, from which it is returned, by means hereinafter described, to the storage-reservoir, from which the pipe B extends, and opening the valve l^5 permits the liquid to flow to waste.

When it is desired to empty the tank A of the liquid contained therein without allowing such liquid to pass over the bridge-walls *b b′*, as for cleaning out the tank or flushing it, the valve l^4 in pipe L^4 is opened; but ordinarily valve l^4 is maintained in a closed condition

m is a centrifugal pump in receptacle M, and *m′* is a pipe from the centrifugal pump *m* to the tank N The liquid flowing into receptacle M through pipe L^2 is forced by the pump *m* into tank N through pipe *m′*.

O is a float-valve in tank N, and O′ is the stem thereof, adapted to close the pipe P (such pipe P extending from a liquid-supply) when the liquid contained in the tank N is raised a determined amount and to open such pipe when less than the determined amount of liquid is contained in such tank. By means of this valve O the pipe P when the liquid returned to the tank N through the pipe *m′* is insufficient to maintain the desired height of liquid in tank N the additional liquid required is automatically supplied through the pipe P.

N′ is the liquid-storage tank from which the liquid is taken through the pipe B to supply the tank A, and *n* is a pipe connecting the tank N with tank N′. The use of pipe *n* is to prevent any pulsation in tank N′ from the movement of the centrifugal pump M or the water passing therethrough into tank N.

In order to supply liquid directly to tank A from tank N, as in the case of desiring to flush the bottom of the tank A, supply-pipe *n′*, having valve n^2 therein, is connected at its upper end with the storage-receptacle N and at its lower end with the tank A.

Q is the cover of the tank A, and Q′ is a slide in cover Q, which can be moved to produce an opening of any desired size in the cover Q.

Q^3 is a partition extending transversely across the tank A from the cover Q to near the surface of the liquid C in the tank.

The slide Q' and the partition Q^2 are adjustable, the joint functions of the two being to determine the quantity of air drawn through the tank by the fan S and its source—that is, when the slide Q^2 is near the surface of the liquid C in the tank and the slide Q' is opened widely nearly all the air passing through the tank will pass through the opening covered by the slide Q', and a small portion thereof will be supplied underneath the slide or partition Q^2, while a larger quantity of air will pass under the partition Q^2 if such partition be raised farther away from the liquid C. The partition Q^2 has another function—namely, to deflect all, if any, particles of ore-stock floating above the liquid C (in the air between the surface of liquid C and cover Q) downward to the surface of such liquid as it passes underneath the slide Q^2.

R is a chamber extending transversely across the tank near the tail end thereof, and r is a perforated screen between the chamber R and the tank A.

R' R' are a series or pipes extending from the chamber R to the transverse pipe or conduit R^2, and r' r' are valves in pipes R' R', respectively.

R^3 is a pipe extending from the transverse pipe R^2 to and communicating with the exhaust-fan S.

S' is the driving-pulley by which the exhaust-fan S is rotated.

When the exhaust-fan S is in operation and the slide Q' in cover Q is open, a current of air will extend from the slide Q' over the surface of the liquid contained in the tank, and from thence through the screen into the chamber R, and from thence through the several pipes R', R^2, and R^3 to and through the exhaust-fan S. By means of the series of valves r' r' and the screen r the amount and direction of the moving current of air can be definitely determined, it being understood that the opening of the slide Q' is properly adjusted for the amount of current desired.

In the operation of this device the liquid entering the tank A through the perforations b^3 b^3 in pipes B^3 B^3 flows over the top of the partitions G G G along toward the tail end of the tank and over the bridge-wall b, an effervescing movement being produced, as hereinbefore described, in the liquid C over the perforations b^3 b^3 b^3 and a wave-like movement being produced the entire length of the tank by the partitions G G G. The buoyed mineral and metallic particles of the ore-stock will be found floating in the form of a scum upon the surface of the liquid along with such liquid toward the tail end of the tank, and when the exhaust-fan S is in operation the wave-like movement of the surface of the liquid is increased and a movement of such buoyed mineral and metallic particles along upon and over the surface of the liquid C at a rate in excess of the rate of movement of the liquid C is obtained, thereby producing a frictional movement facilitating the separation of such buoyed mineral and metallic particles from the gangue of the ore-stock, whereby the capacity of the separator is increased.

Having thus described our invention, what we claim, and desire to secure by Letters Patent, is—

1. The herein-described process for concentrating ores, which consists in commingling with pulverized ore-stock buoyant material, then submitting the commingled pulverized ore-stock and buoyant material to movement and pressure and so joining the buoyant material to the metallic and mineral particles in the pulverized ore, and then applying the prepared ore while in a dry state to a stratifying apparatus, whereby the buoyed metallic and mineral particles are separated from the gangue by the settling of such gangue, substantially as described.

2. The herein-described process for concentrating ores, which consists in first commingling with pulverized ore-stock buoyant material, then submitting the commingled pulverized ore-stock and buoyant material to movement and pressure and so joining the buoyant material to the metallic and mineral particles in the pulverized ore, and then applying such prepared ore while in a dry state to the surface of liquid, whereby the buoyed metallic and mineral particles are floated on such liquid and separated from the gangue, which settles in the liquid, substantially as described.

3. The process, substantially as described, for concentrating ores, which consists in first joining the metallic and mineral particles in the pulverized ore with a quantity of buoyant material and then sifting or blowing the prepared ore while in a dry state upon the surface of liquid, whereby the buoyed metallic and mineral particles are made to float and thus separate from the gangue, which settles.

4. The herein-described process for concentrating ores, which consists in first joining the metallic and mineral particles in the pulverized ore with a quantity of buoyant material, then sifting or blowing the prepared ore while in a dry state upon the surface of liquid, and then in obtaining a current of air over the liquid, whereby the buoyed metallic and mineral particles are made to float and to move along on and over the surface of such liquid, and thus separate from the gangue, which settles.

5. The herein-described process for concentrating ores, which consists in first joining the metallic and mineral particles in the pulverized ore with a quantity of buoyant material, of obtaining a body of liquid having an effervescent condition, and then sifting or blowing the prepared ore while in a dry state upon the surface of liquid in such effervescing condition, whereby the buoyed metallic and mineral particles are made to

float on the surface of such liquid, and thus separate from the gangue, which settles.

6. The herein-described process for concentrating ores, which consists in first joining the metallic and mineral particles in the pulverized ore with a quantity of buoyant material, of obtaining a body of liquid having an effervescent condition, then sifting or blowing the prepared ore while in a dry state upon the surface of liquid in such effervescing condition, and then in obtaining a current of air over the liquid, whereby the buoyed metallic and mineral particles are made to float and to move along on and over on the surface of such liquid, and thus separate from the gangue, which settles.

CHARLES B. HEBRON.
CARRIE J. EVERSON.

Witnesses to signature of Charles B. Hebron:

CHARLES T. BROWN,
J. L. EVERSON.

Witnesses to signature of Carrie J. Everson:

E. A. FAY,
B. CURTIS.

No. 653,340. Patented July 10, 1900.

F. E. ELMORE.

APPARATUS FOR SEPARATING METALLIC FROM ROCKY CONSTITUENTS OF ORES.

(Application filed Sept. 23, 1899.)

(No Model.) 2 Sheets—Sheet 1.

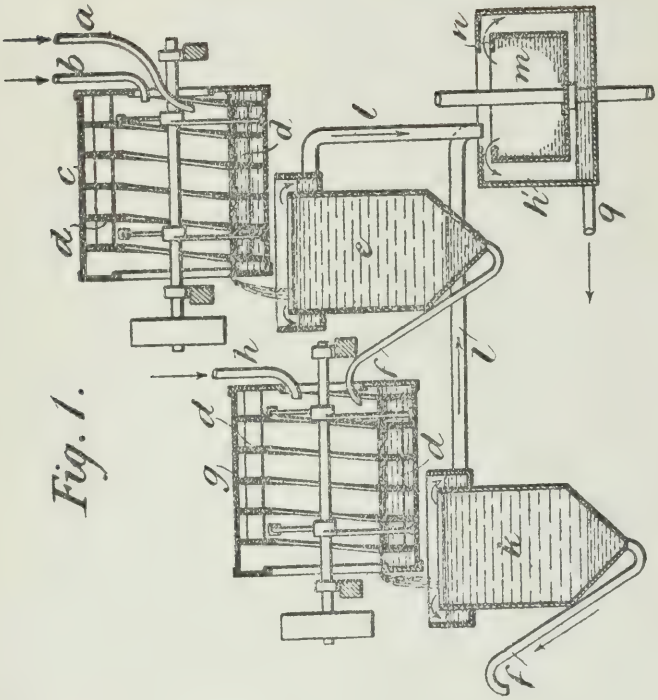


Fig. 1.

Witnesses

[illegible]

[illegible]

Inventor

Francis E. Elmore

by James L. Norris

att'y

No. 653,340. Patented July 10, 1900.

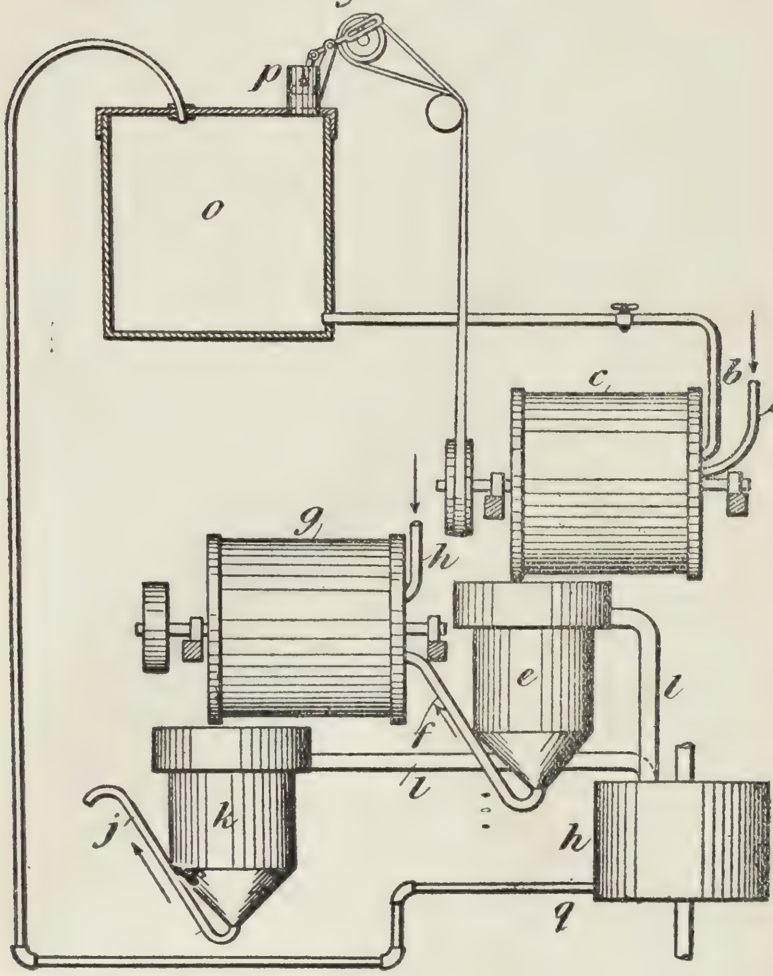
F. E. ELMORE.

APPARATUS FOR SEPARATING METALLIC FROM ROCKY CONSTITUENTS OF ORES.

(Application filed Sept. 23, 1899.)

(No Model.) 2 Sheets—Sheet 2

Fig. 2.



Witnesses

H. B. Keefer

Dennis Sumby.

Inventor

Frances E. Elmore

by James L. Norris

Atty.

UNITED STATES PATENT OFFICE.

FRANCIS EDWARD ELMORE, OF LEEDS, ENGLAND.

APPARATUS FOR SEPARATING METALLIC FROM ROCKY CONSTITUENTS OF ORES.

SPECIFICATION forming part of Letters Patent No. 653,340, dated July 10, 1900.

Original application filed April 10, 1899, Serial No. 712,454. Divided and this application filed September 23, 1899. Serial No. 731,464. (No model.)

To all whom it may concern:

Be it known that I, FRANCIS EDWARD ELMORE, a citizen of England, residing at Pontefract road, Hunslet, Leeds, in the county of York, England, have invented certain new and useful Improvements in Apparatus for Separating Metallic from Rocky Constituents of Ores, (for which I have applied for a patent in Great Britain, dated October 18, 1898, No. 21,948,) of which the following is a specification.

This invention, which was originally comprised in the application for patent filed April 10, 1899, Serial No. 712,454, but has been divided out at the request of the Office, relates to apparatus for separating the metallic from the rocky constituents of ores, which I effect by bringing a mixture of the pulverized ore with water into contact with more or less thick oil, which entraps the metallic constituents and allows the rocky constituents to pass away with the water. I then separate the metallic particles from the oil, which can be used for repeated operations. The thick oil which I employ is the thick tarry residue, usually called "residuum," of mineral oil after some of the more volatile constituents have been distilled off. When the whole of the one has been mixed with water in quantity amounting to several times the weight of the ore, this is then mixed with the thick oil. The metallic portions of the ore are retained in the oil, which does not even adhere to the earthy ingredients, the latter being held in suspension in the water.

In the accompanying drawings, Figure 1 is a vertical sectional view of an apparatus suitable for carrying my invention into effect, omitting the elevated cistern; and Fig. 2 is a side elevation of the apparatus, showing the elevated cistern.

In order to enable those skilled in the art to practice my invention, I will now describe the same in detail with reference to the drawings.

The mixture of pulverized ore and water supplied by pipe a and also the oil supplied by pipe b flow into one end of a drum c, which slowly revolves on a horizontal axis. At each end of the drum there is a circular opening, and within the drum annular helical ribs d extend from end to end, the spaces between these ribs being divided into cells by a number of equidistant blades. The ore and water and the oil, which are thus mingled without being broken up, so as to form a uniform mixture, are carried from the end of the drum where they entered to the opposite end, whence they are discharged into a water-subsiding vessel e, in which the water and rocky constituents mostly subside, while the oil, with the metallic constituents, floats above. The lowest layer is drawn away as tailings, which may be again treated with oil by leading them by a pipe f to a second drum g, where they are again mixed with oil supplied by a pipe h, the mixture being discharged into a second subsidence vessel k. This may be again repeated until little or none of the metallic constituents remain in the tailings. The upper layer from the subsidence vessels is led by pipes l into a centrifugal drum m, containing a little water. As the drum rapidly revolves the metallic particles are caused by centrifugal force to pass from the oil to the water, which forms a layer next the circumference of the drum, the side of which is closed, while the oil, being lighter, flows over an inwardly-projecting lip n into the casing h' of the drum, whence it is removed by a pipe q to be used over again. When the layer of particles and water in the centrifugal drum attains a certain thickness, the drum is stopped, the layer is removed, and the drum receives a fresh charge of water and is again worked.

The oil may be pumped up through pipe q to an elevated cistern o to supply the drums c and g; but in order to clear the oil from air-bubbles I prefer to draw the oil up to the cistern by creating a partial vacuum in the cistern through the medium of any suitable means, such as a vacuum-pump p.

In carrying out my invention I do not employ an oil mixture. The thick oil of the kind before set forth, with the metallic ingredients entrapped in it, floats over the water, which holds in suspension the earthy ingredients which have no oil whatever adhering to them.

Instead of employing centrifugal force to separate the oil from the metallic matters mixed with it the mixture may be thinned by heating it or mingling it with solvents of the

oil, such as benzoline, and left for subsidence or subjected to filter-pressing, so that the greatest portion of the oil can be recovered for subsequent use.

Having thus described the nature of this invention and the best means I know of carrying the same into practical effect, I claim—

1. The combination in an apparatus for separating metallic from rocky constituents of ore, of a rotary drum having internal helical ribs, pipes for delivering oil and ore and water into one end of said drum, a water-subsiding vessel arranged below the drum and receiving the oil, ore and water therefrom, a centrifugal drum arranged below said water-subsiding vessel, and a pipe for conducting the metallic portions and the oil from the top of the water-subsiding vessel into said centrifugal drum, substantially as described.

2. The combination in an apparatus for separating metallic from rocky constituents of ore, of a rotary drum having internal helical ribs divided into cells by longitudinal blades, pipes for delivering oil and ore and water into one end of said drum, a water-subsiding vessel arranged below the drum and receiving the oil, ore and water therefrom, a centrifugal drum arranged below the water-subsiding vessel and constructed with an inwardly-projecting lip and a surrounding casing, and a pipe for conducting the metallic portions and oil from the top portion of the water-subsiding vessel into said centrifugal drum at a point in proximity to the inwardly-projecting lip thereof, substantially as described.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

FRANCIS EDWARD ELMORE.

Witnesses:
FRANCIS W. FRIGOUT,
A. NUTTING.

No. 676,679. Patented June 18, 1901.

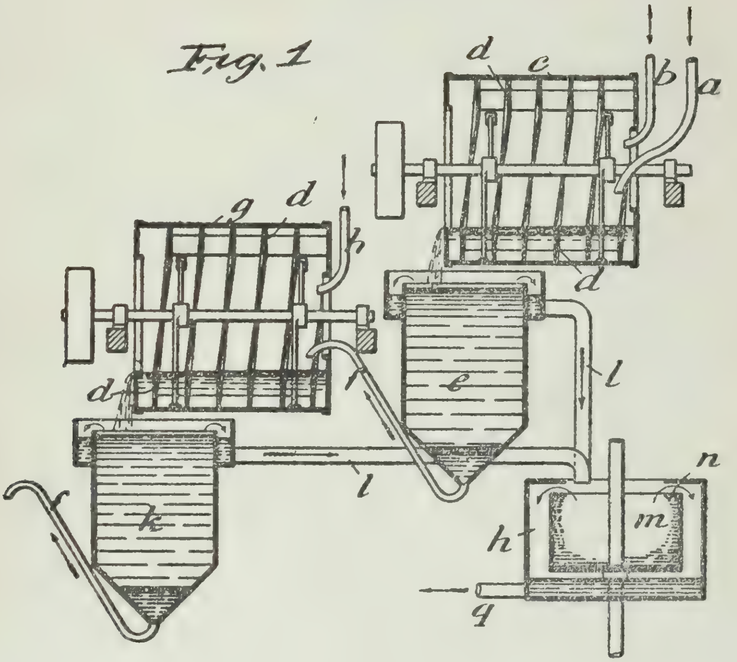
F. E. ELMORE.

PROCESS OF SEPARATING METALLIC FROM ROCKY CONSTITUENTS OF ORES.

(Application filed Apr. 10, 1899.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 1



Witnesses
[signature]
Bruce S. Elliott

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Francis E. Elmore
By James L. Norris
Atty.

No. 676,679. Patented June 18, 1901.

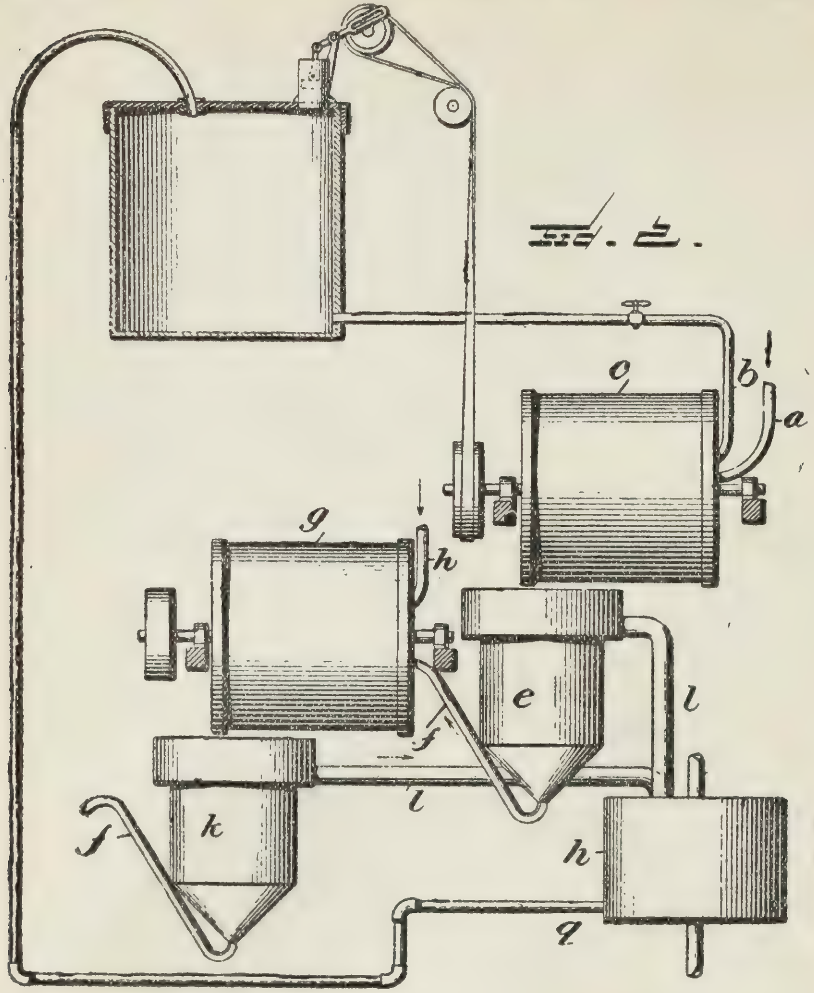
F. E. ELMORE.

PROCESS OF SEPARATING METALLIC FROM ROCKY CONSTITUENTS OF ORES.

(Application filed Apr 10, 1899.)

(No Model.) 2 Sheets—Sheet 2

Fig. 2.



Witnesses
L C Hills
W. D. Keefer

Inventor
Francis E. Elmore
By James L. Norris
Attorney

UNITED STATES PATENT OFFICE.

FRANCIS EDWARD ELMORE, OF LEEDS, ENGLAND.

PROCESS OF SEPARATING METALLIC FROM ROCKY CONSTITUENTS OF ORES.

SPECIFICATION forming part of Letters Patent No. 676,679, dated June 18, 1901.

Application filed April 10, 1899. Serial No. 712,454. (No specimens.)

To all whom it may concern:

Be it known that I, FRANCIS EDWARD ELMORE, electrometallurgist, a citizen of England, residing at Pontefract road, Hunslet, Leeds, in the county of York, England, have invented certain new and useful Improvements in Processes of Separating Metallic from Rocky Constituents of Ores, (for which I have applied for a patent in Great Britain, dated October 18, 1898, No. 21,948,) of which the following is a specification.

My invention relates to a method of separating metallic constituents of ore from rocky and other impurities, which is distinguished from the usual amalgamation processes in which the ore forms an amalgam with mercury.

It consists in mixing the crushed ore with water and mixing with the ore and water a substance other than mercury which has the power of causing the metallic portions of the ore only to adhere to it, while the water and rock or other impurities of the ore remain unaffected and may be drawn off. The metallic constituents of the ore are then recovered from the substance in which they are entrapped. I have found that the heavier oils are efficacious for this purpose and particularly that kind of oil known as the "residuum" of mineral oil after the more volatile elements have been distilled off.

In carrying out my process I prefer to mix the ore with water—as, for instance, by the wet crushing method in common use—using a sufficient quantity of water to make a freely-flowing mixture, the fineness of the ore depending upon the particular kind of ore treated. I then place the ore and water in a suitable vessel, add a quantity of the oil depending upon the particular kind of ore under treatment, and then agitate the mixture without breaking up the oil into small globules. The metallic particles will adhere to the oil and be buoyed up and floated by it, while the other constituents of the ore will remain in the water. The water and attendant impurities are then drawn off, leaving the oil and metallic particles. The metallic particles are easily separated from the oil by mechanical or other means.

In the accompanying drawings, Figure 1 is a vertical sectional view of an apparatus suitable for carrying my invention into practice, omitting the elevated cistern; and Fig. 2 is a side elevation of the apparatus, showing the elevated cistern.

In order to enable those skilled in the art to practice my invention, I will now describe the same in detail, with reference to the drawings.

The mixture of pulverized ore and water supplied by pipe *a* and also the oil supplied by pipe *b* flow into one end of a drum *c*, which slowly revolves on a horizontal axis. At each end of the drum there is a circular opening, and within the drum annular helical ribs *d* extend from end to end, the spaces between these ribs being divided into cells by a number of equidistant blades. The ore and water and the oil, which are thus mingled without being broken up so as to form a uniform mixture, are carried from the end of the drum where they entered to the opposite end, whence they are discharged into a vessel *e*, in which the water and rocky constituents mostly subside, while the oil, with the metallic constituents, floats above. The lowest layer is drawn away as tailings, which may be again treated with oil by leading them by a pipe *f* to a second drum *g*, where they are again mixed with oil supplied by a pipe *h*, the mixture being discharged into a second subsidence vessel *k*. This may be again repeated until little or none of the metallic constituents remain in the tailings. The upper layer from the subsidence vessels is led by pipes *l* into a centrifugal drum *m*, containing a little water. As the drum rapidly revolves the metallic particles are caused by centrifugal force to pass from the oil to the water, which forms a layer next the circumference of the drum, the side of which is closed, while the oil, being lighter, flows over an inwardly-projecting lip *n* into the casing *h'* of the drum, whence it is removed by a pipe *q* to be used over again. When the layer of particles and water in the centrifugal drum attains a certain thickness, the drum is stopped, the layer is removed, and the drum receives a fresh charge of water and is again worked.

The oil may be pumped up through pipe *q* to an elevated cistern *o* to supply the drums *c* and *g*; but in order to clear the oil from

air-bubbles I prefer to draw the oil up to the cistern by creating a partial vacuum in the cistern through the medium of any suitable means, such as a vacuum-pump p'.

In carrying out my invention I do not employ an oil mixture. The thick oil of the kind before set forth, with the metallic ingredients entrapped in it, floats over the water, which holds in suspension the earthy ingredients which have no oil whatever adhering to them.

Instead of employing centrifugal force to separate the oil from the metallic matters mixed with it the mixture may be thinned by heating it or mingling it with solvents of the oil, such as benzolin, and left for subsidence or subjected to filter-pressing, so that the greatest portion of the oil can be recovered for subsequent use.

Having thus described the nature of this invention and the best means I know of carrying the same into practical effect, I claim—

1. The process of separating the metallic from other constituents of ore, which consists in mixing with crushed ore to which sufficient water has been added to make a flowing mixture a substance other than mercury to which the metallic particles only will adhere, and then recovering the metallic particles from such substance, substantially as described.

2. The process of separating the metallic constituents of ore from the rocky or other impurities, which consists in mixing crushed ore with a sufficient quantity of water to make a flowing mixture, mixing with the ore and water a quantity of oil, and recovering the metallic particles from the oil, substantially as described.

3. A process of separating the metallic from the other constituents of ore, which consists in mixing crushed ore and water to form a flowing mixture, mixing with the ore and water a substance other than mercury to which the metallic particles only will adhere, separating the water and impurities from the substance containing the metal, and recovering the metal from such substance, substantially as described.

4. The method of separating the metallic from other constituents of ore which consists of commingling pulverized ore to which sufficient water has been added to make a flowing mixture with oil, separating the oil and metallic constituents contained therein from the water and impurities, and separating the metallic constituents from the oil, substantially as described.

5. A process for separating metallic from rocky constituents of ore by mixing the pulverized ore with water and mixing the ore and water with oil, allowing the water carrying rocky materials to subside, while the oil carrying metallic constituents floats above, and separating the oil from these constituents substantially as described.

6. The improved process for separating metallic from rocky constituents of ore which consists in mixing the pulverized ore with water, flowing the same into contact and admixture with flowing oil, subjecting the mixture of ore, water and oil to subsidence, and then separating the oil from the rocky constituents and water, substantially as described.

7. The herein-described process for separating the metallic from the rocky constituents of ore, which consists in first mixing pulverized ore with a large quantity of water to maintain the mixture in a freely-flowing condition, then adding to this mixture of water and ore a thick oil of the character set forth, which oil will adhere to the metallic constituents but not to the wet rocky constituents, then subsiding the water and rocky material and causing the oil carrying the metallic constituents to float off over the body of water and finally separating said oil from said metallic constituents, substantially as specified.

8. The herein-described process for separating the metallic from the rocky constituents of ore, which consists in first mixing pulverized ore with a large quantity of water to maintain the mixture in a freely-flowing condition, then adding to this mixture of water and ore a thick oil of the character set forth, which oil will adhere to the metallic constituents but not to the wet rocky constituents, then subsiding the water and rocky material and causing the oil carrying the metallic constituents to float off over the body of water and finally separating said oil from said metallic constituents by centrifugal action, substantially as specified.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

FRANCIS EDWARD ELMORE.

Witnesses:

THOMAS BROWN,

THOBIAS HENRY BUTT.

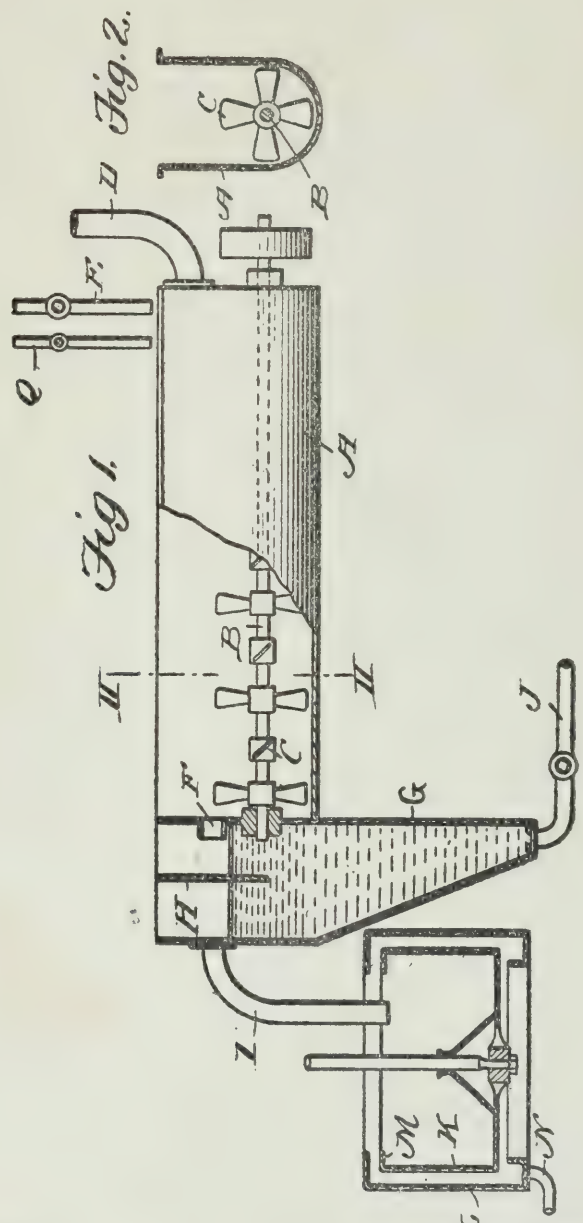
No. 689,070. Patented Dec. 17, 1901.

A. S. ELMORE.

SEPARATING MINERAL SUBSTANCES BY THE SELECTIVE ACTION OF OIL.

(Application filed Apr. 13, 1901.)

(No Model.)



Witnesses:
C. W. Kesler
H. B. Keefer

Inventor
Alexander S. Elmore
By James L. Norris
Atty.

UNITED STATES PATENT OFFICE.

ALEXANDER STANLEY ELMORE, OF LONDON, ENGLAND

SEPARATING MINERAL SUBSTANCES BY THE SELECTIVE ACTION OF OIL.

SPECIFICATION forming part of Letters Patent No. 689,070, dated December 17, 1901

Application filed April 13, 1901. Serial No. 55,776. (No specimens.)

To all whom it may concern:

Be it known that I, ALEXANDER STANLEY ELMORE, a citizen of England, residing at 4 Bishopsgate street Within, London, England, have invented a certain new and useful Improvement in Separating Mineral Substances by the Selective Action of Oil, (for which I have applied for a patent in Great Britain, dated March 28, 1901, No. 6,519,) of which the following is a specification.

The selective action of oil has been utilized for separating metallic substances from earthy or rocky constituents of ores. This has generally been done by pulverizing the ore and suspending it in a considerable quantity of water, so as to make a freely-flowing pulp, then mingling with it oil, preferably heavy oil, such as is obtained from petroleum after some of the lighter oils have been distilled from it. When the mixture rests, the oil, with most of the metallic substances entrapped in it, floats at the top and is separated from the rocky or earthy matters, which are run off with the water as tailings. The oil is afterward separated from the metallic substances, usually by centrifugal action. In carrying on this separating process I have discovered that in some cases a slight acidulation of the mixture greatly enhances the selective action of the oil, so that metallic substances, as well as other mineral substances, such as sulfur and plumbago, can be separated from the earthy matters with which they are naturally associated better than when there is no acid present. By this means some metallic substances can be separated from others—such, for instance, as sulfids from oxids. The acidulation may be effected either by adding a little acid to the oil, in which case an acid that will dissolve in or mix readily with the oil, but which is insoluble, or nearly so, in water—as, for instance, oleic acid—is to be preferred, or the acid may be added to the aqueous pulp, in which case sulfuric acid may be employed or the acid cuprous liquors obtained in mine working. The quantity of acid added in either case is small, as it often need not exceed one five-hundredth part of the volume of oil or water employed in the operation. The quantity of acid required to produce the best result varies, according to the character of the material treated, and I therefore do not confine myself to any definite proportion.

An apparatus by which my process can be carried out in practice and which forms the subject of a pending application for Letters Patent filed the 8th day of August, 1901, Serial No. 71,372, is illustrated by the accompanying drawings, in which—

Figure 1 is a view partly in section and partly in elevation, and Fig. 2 a cross-sectional view.

In applying my invention to the separation of metallic and earthy or rocky ingredients of ore I prefer to mix with the powdered ore from five to ten times its weight of water, forming a thin freely-flowing pulp, which I allow to flow into the mixer A through a pipe D. Into this mixer I also admit a thin stream of oil from a pipe E, provided with a regulating-valve, and a small quantity of acid from a pipe Q, also provided with a regulating-valve. The oil and acid are mixed with the pulp by the rotating beater C. The oil by its selective action coats or absorbs the metallic particles, sulfids, the tellurids, and the like. If plumbago, elementary sulfur, or other substances of like character are present, the oil attaches itself to or coats such particles, while it does not coat or attach itself to the rocky or earthy particles present. The liquid mineral pulp, oil, and acid are caused to travel along the mixer A and become thoroughly mixed. This mixture issues by an opening F into a subsidence-tank G, which has in its upper part a partition H, extending down a little below the level of an outlet-pipe I. In the tank G a separation takes place of the metallic from the rocky or earthy ingredients of the mixture, the metallic ingredients adhering to the oil and by it floated to the top on the left side of the partition H, while the earthy and rocky ingredients subside and are allowed to issue through a pipe J, provided with a regulating-cock. The metallic ingredients, with the oil and acid, are discharged by the pipe I into the drum K of a centrifugal machine which revolves rapidly in a casing L. The drum has an inwardly-projecting flange M at its upper edge. As the drum revolves the metallic matters, owing to their density, accumulate in an annular layer at the circumference of the drum, while the oil

and acid collect inside and flow over the flange M into the casing L, whence they are conducted away through a pipe N. From time to time the revolution of the drum is stopped and the metallic matter removed.

Having thus described the nature of this invention and the best means I know of carrying the same into practical effect, I claim—

The process for separating metallic and rocky constituents of ore which consists in mixing pulverized ore with water and mixing the ore and water with oil in the presence of an acid, allowing the mixture to rest whereby the oil having the metallic substances entrapped in it floats at the top of the mixture, and separating the metallic constituents from the oil, substantially as described.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

ALEXANDER STANLEY ELMORE.

Witnesses:

GERALD L. SMITH,
W. M. HARRIS.

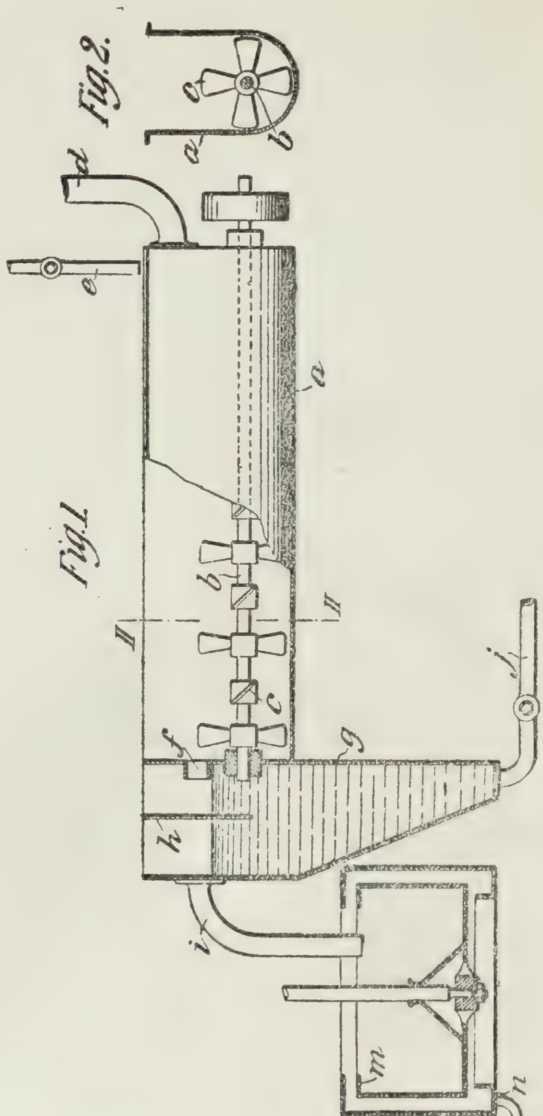
No. 692,643. Patented Feb. 4, 1902.

A. S. ELMORE.

APPARATUS FOR SEPARATING MINERALS BY SELECTIVE ACTION OF OILS.

(Application filed Aug. 8, 1901.)

(No Model.)



Witnesses
Howard Hume

Inventor
Alexander S. Elmore
By James L. Norris
Atty.

UNITED STATES PATENT OFFICE.

ALEXANDER S. ELMORE, OF LONDON, ENGLAND.

APPARATUS FOR SEPARATING MINERALS BY SELECTIVE ACTION OF OILS.

SPECIFICATION forming part of Letters Patent No. 692,643, dated February 4, 1902.

Application filed August 8, 1901. Serial No. 71,372. (No model.)

To all whom it may concern:

Be it known that I, ALEXANDER STANLEY ELMORE, a citizen of England, residing at 4 Bishopsgate street within, in the city of London, England, have invented a certain new and useful Apparatus for Separating Minerals by the Selective Action of Oils, of which the following is a specification.

This invention relates to apparatus for effecting the separation of minerals by the selective action of oils, as I shall describe, referring to the accompanying drawings.

Figure 1 is an elevation, partly sectional, of apparatus according to my invention. Fig. 2 is a transverse section on the line II II of Fig. 1.

a is a trough having a rounded bottom, in which a shaft *b*, carrying a number of inclined agitating-blades *c*, is caused to revolve by any suitable power. Into one end of the trough leads a pipe *d*, by which pulverized ore or mineral mixed with five to ten times its volume of water is fed into the trough, while oil is fed by a pipe *e* in quantity regulated by a cock. As the liquid mineral pulp and oil are caused by the blades *c* to travel along the trough *a* they become thoroughly mixed, and the mixture issues by an opening *f* into a subsidence-tank *g*, which has in its upper part a partition *h*, extending down a little below the level of an outlet-pipe *i*. In the tank *g* a separation takes place of the metallic from the rocky or earthy ingredients of the mixture, the metallic ingredients adhering to the oil and by it floated to the top on the left side of the partition *h*, while the earthy and rocky ingredients subside and are allowed to issue by a pipe *j*, provided with a regulating-cock. The metallic ingredients, with the oil, are discharged by the pipe *i* into the drum *k* of a centrifugal machine, which revolves rapidly in a casing *l*. The drum *k* has an inwardly-projecting flange *m* at its upper edge. As the drum revolves the metallic matters, owing to their density accumulate in an annular layer at the circumference of the drum, while the oil collects inside them and overflows over the flange *m* into the casing *l*, whence it flows by a pipe *n*. From time to time the revolution of the drum is stopped and the metallic matter is removed from it.

Having thus described the nature of this invention and the best means I know of carrying the same into practical effect, I claim—

The combination in an apparatus for separating metallic from rocky constituents of ore, of a trough, a shaft adapted to revolve within said trough and provided with inclined blades, pipes for delivering oil and water to said trough, a subsidence-tank arranged at one end of said trough, extending below the same and communicating therewith, said tank adapted to receive the liquid mineral pulp and oil from said trough, a vertically-extending partition arranged in said tank at the top thereof for the purpose set forth, a centrifugal drum arranged at one side of said tank, a pipe connected to said tank and communicating with said drum for discharging therein the metallic ingredients and the oil, and a pipe connected to the tank for discharging therefrom the earthy and rocky ingredients.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

A. S. ELMORE.

Witnesses:

WALTER JAMES SKERTEN,

GERALD L. SMITH.

No. 729,805. PATENTED JUNE 2, 1903.

J. & L. STOVEKEN.

APPARATUS FOR EXTRACTING METALS FROM ORES.

APPLICATION FILED AUG. 12, 1902.

NO MODEL. 5 SHEETS—SHEET 1.

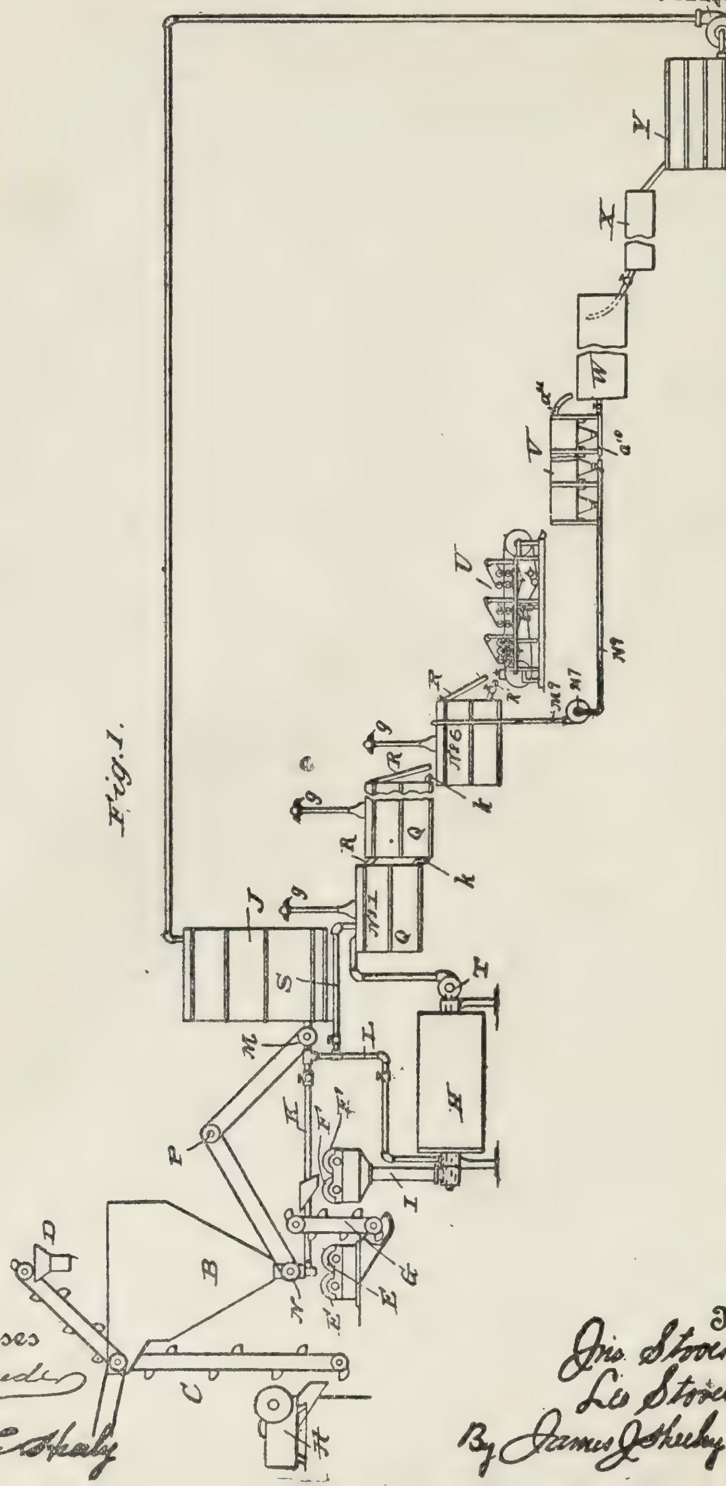


Fig. I.

Witnesses

[signature]

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Inventors

Jno. Stoveken &

Leo Stoveken

By James J. Sheehy Attorney

No. 729,805. PATENTED JUNE 2, 1903.

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APPARATUS FOR EXTRACTING METALS FROM ORES.

APPLICATION FILED AUG. 13, 1902.

NO MODEL. 6 SHEETS—SHEET 2.

Fig. 2.

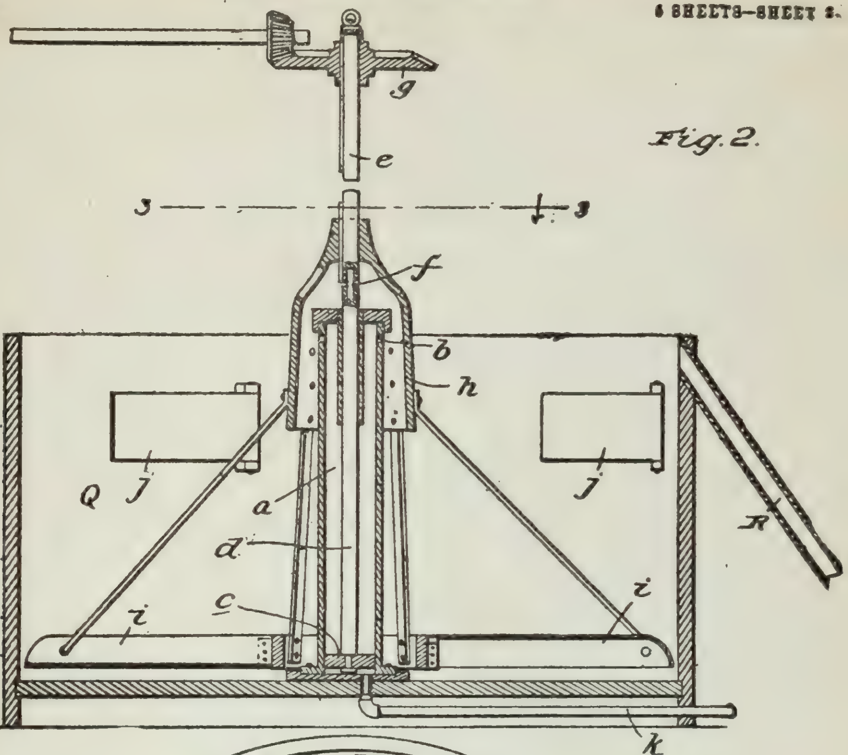
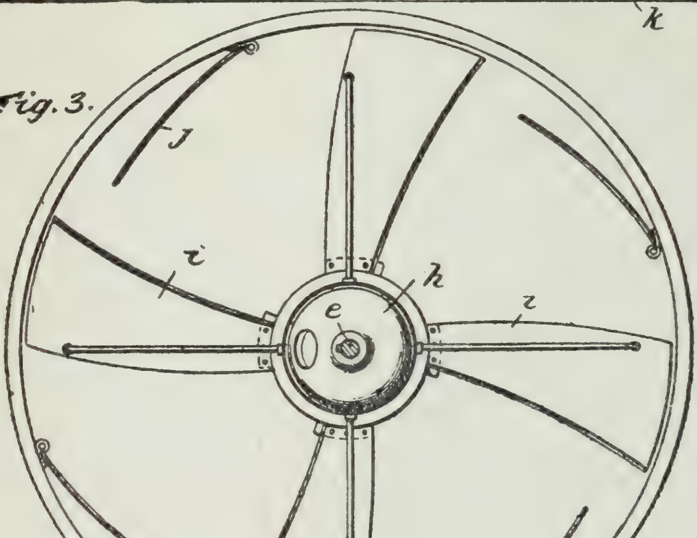


Fig. 3.



Witnesses
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No. 729,805 PATENTED JUNE 2, 1903.

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APPARATUS FOR EXTRACTING METALS FROM ORES.

APPLICATION FILED AUG. 12, 1902.

NO MODEL. 6 SHEETS—SHEET 3.

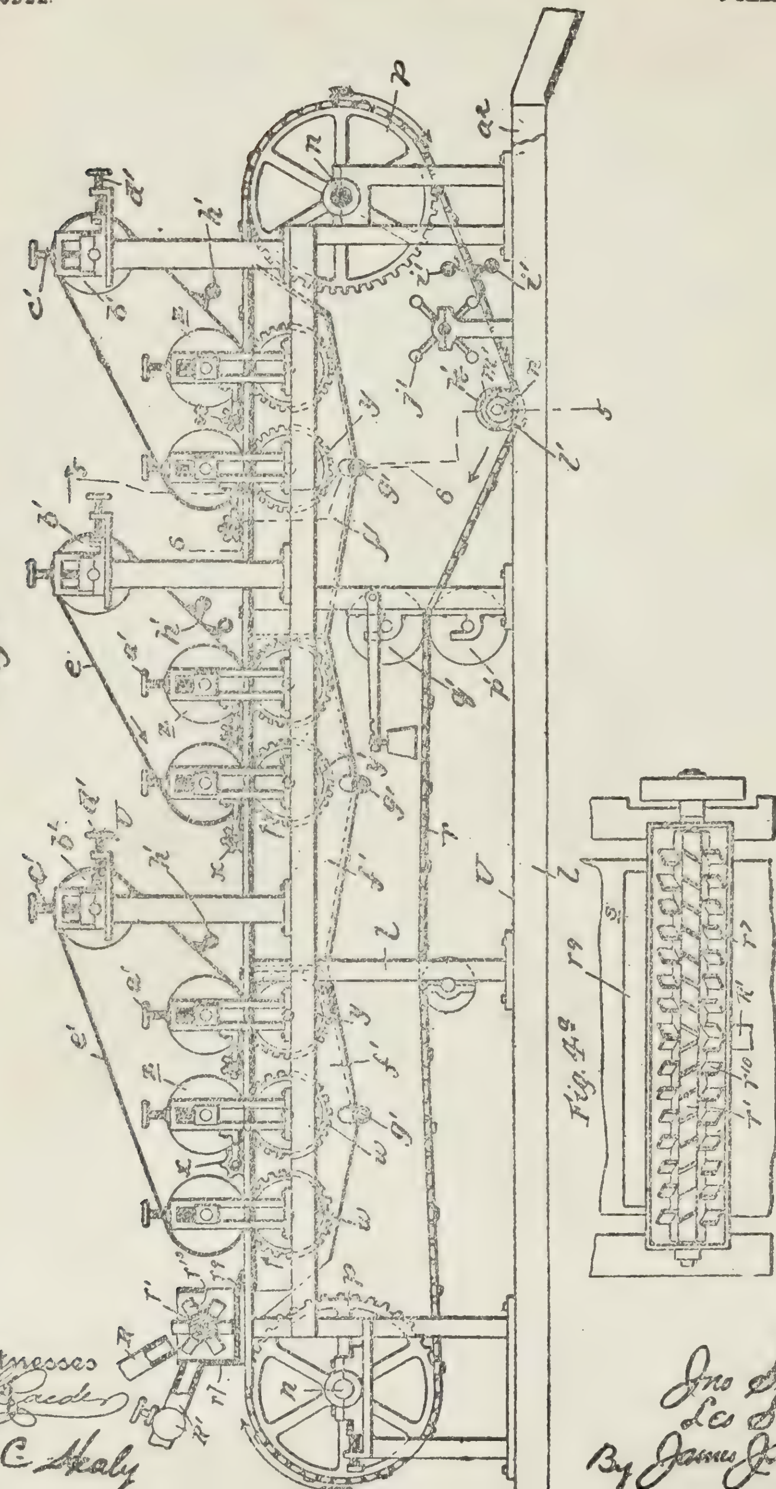

Fig. 4.

Fig. 4ª

Witnesses

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APPARATUS FOR EXTRACTING METALS FROM ORES.

APPLICATION FILED AUG. 12, 1902.

NO MODEL. 5 SHEETS—SHEET 4.

Fig. 5.

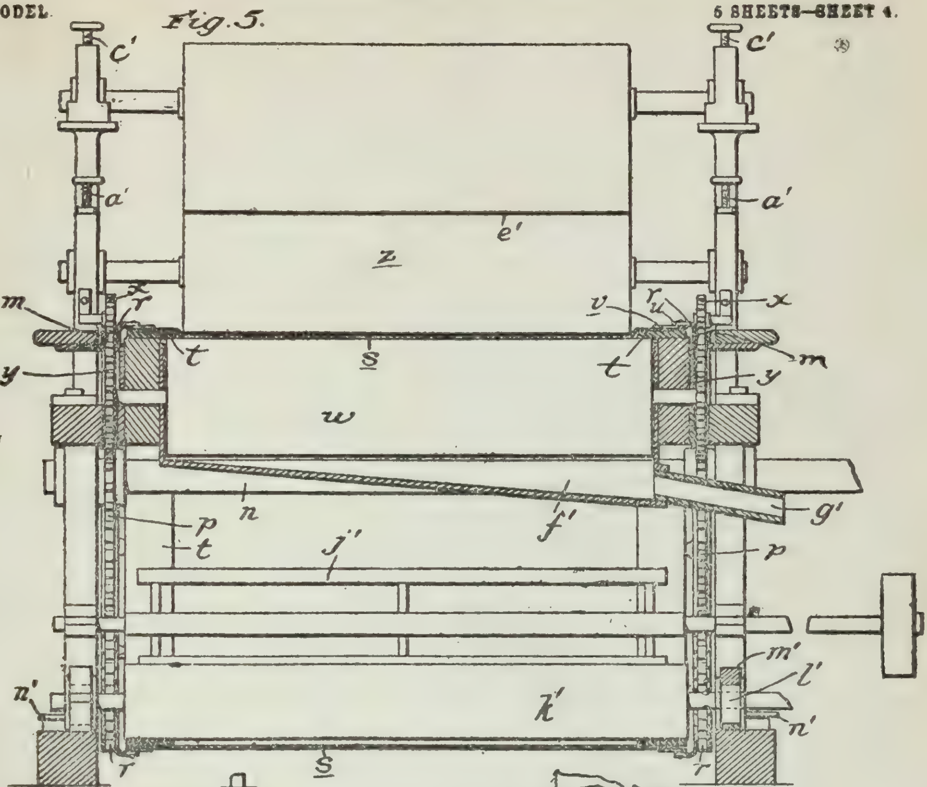


Fig. 6.

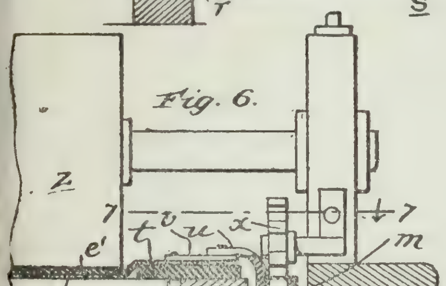
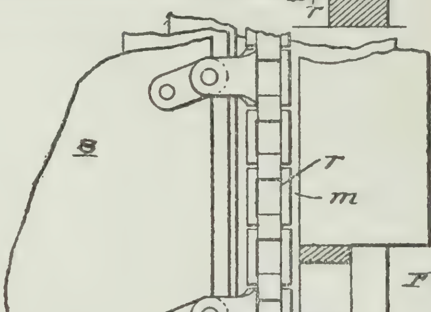


Fig. 7.



Witnesses

[signature]

N. C. Healy

Inventors

Jno Stoveken &

Les. Stoveken

By James J. Sheehy Attorney

No. 729,805. PATENTED JUNE 2, 1903.

J. & L. STOVEKEN.

APPARATUS FOR EXTRACTING METALS FROM ORES.

APPLICATION FILED AUG. 12, 1902.

NO MODEL. 6 SHEETS—SHEET 6.

Fig. 8.

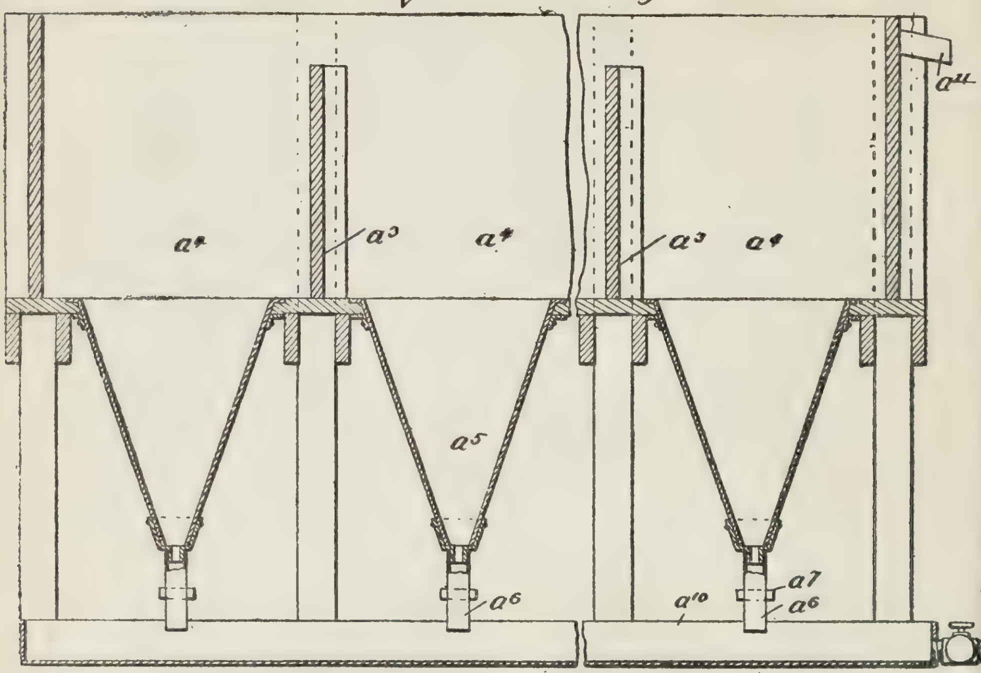
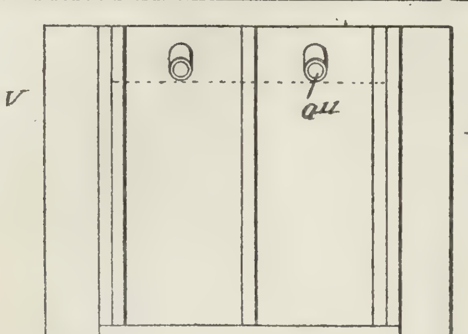


Fig. 9.



Witnesses
C. H. Spauler
R. C. Healy

Inventors
Jno. Stoveken &
Leo Stoveken
By James J. Sheehy Attorney

No. 729,805. Patented June 2, 1903.

UNITED STATES PATENT OFFICE.

JOHN STOVEKEN, OF CRIPPLECREEK, AND LEO STOVEKEN, OF FLORENCE, COLORADO.

APPARATUS FOR EXTRACTING METALS FROM ORES.

SPECIFICATION forming part of Letters Patent No. 729,805, dated June 2, 1903.

Application filed August 12, 1902. Serial No. 119,433. (No model.)

To all whom it may concern:

Be it known that we, JOHN STOVEKEN, residing at Cripplecreek, in the county of Teller, and LEO STOVEKEN, residing at Florence, in the county of Fremont, State of Colorado, citizens of the United States, have invented new and useful Improvements in Apparatus for Extracting Metals from Their Ores, of which the following is a specification.

Our invention relates to apparatus for extracting precious metals from their ores; and it has for its general object to provide an apparatus designed more especially for the treatment of ores in which only a small percentage can be saved by amalgamation and which ores are of too low grade to be treated by barrel chlorination and too clayey or slimy to be percolated by cyanid solution.

The invention will be fully understood from the following description and claims when taken in conjunction with the accompanying drawings, in which—

Figure 1 is a broken side elevation of the apparatus constituting the preferred embodiment of our invention; Fig. 2, an enlarged diametrical section of one of the agitation-tanks forming part of the apparatus; Fig. 3, a section taken in the plane indicated by the broken line 3 3 of Fig. 2 looking downwardly; Fig. 4, an enlarged side elevation of the filter forming part of the apparatus; Fig. 4ª, a detailed plan view of the spreader comprised in the filter; Fig. 5, a slightly-enlarged transverse section taken on the broken line 5 5 of Fig. 4; Fig. 6, an enlarged detail section taken on the broken line 6 6 of Fig. 4; Fig. 7, a detail horizontal section taken in the plane of the broken line 7 7 of Fig. 6 looking downwardly; Fig. 8, a broken longitudinal vertical section of the decanting-vat forming part of the apparatus, and Fig. 9 an end elevation of the same with a portion of the trough broken away.

Similar letters of reference designate corresponding parts in all of the several views of the drawings, referring to which—

A, Fig. 1, is an ore-crusher, which may be of any suitable description; B, a bin for containing crushed ore; C, an elevator for transferring the crushed ore from the crusher to the bin; D, a sampler which is preferably employed, but which *per se* forms no part of our invention and may therefore be omitted when desired; E E, rolls disposed below the discharge of the bin B and having for their purpose to reduce the size of the pieces of ore; F F, rolls, the purpose of which is to further reduce the size of the pieces of ore; G, an endless elevator arranged to receive the ore as it comes from the rolls E and transfer it to the rolls F; H, a pulverizer, preferably a ball-pulverizer, which has for its purpose to reduce the ore to a finely-divided or comminuted state; I, a conduit for conducting the ore from the discharge of the rolls F to the pulverizer; J, a tank for containing the cyanid solution or other solvent used in the operation of the apparatus; K, a conduit, preferably valved, which leads from the tank J and has discharges disposed over the rolls E and F, this to effect a mixture of the solution and ore incident to the grinding of the latter by said rolls; L, a conduit, preferably valved, which leads from the conduit K to the pulverizer H and has for its purpose to supply solution to the pulverizer, and thereby assure the ore being ground exceedingly fine in the presence of the solution; M, a measuring device or meter of any suitable description arranged in the conduit K between the solution-tank J and the conduit L; N, an ore-feeding device of any suitable description controlling the discharge of the bin B; P, a counter-shaft from which the pump M and the ore-feeding device N are driven, this to assure a supply of solution to the rolls E and F and the pulverizer H commensurate with the quantity of ore discharged from the bin B; Q Q, agitation-tanks, of which six are preferably employed, said tanks being arranged one below the other and being provided with discharge-conduits R, so as to enable the mixed solution and comminuted ore to flow by gravity from the tank nearest the pulverizer H to the next lower tank, and so on until they reach the last tank—*i. e.*, the lowest tank and that farthest from the pulverizer, from which they flow to the filter, presently described; S, a conduit, preferably valved, leading from the conduit L to the agitation-tank No. 1—*i. e.*, the uppermost tank of the series—and designed to supply said tank with the cyanid or other solution

employed; T, a suitable sand-pump interposed between and connected to the pulverizer H and the agitation-tank No. 1 and having for its purpose to move the solution and comminuted ore from the former to the latter; U, a filter arranged to receive the comminuted ore and solution from the last of the agitation-tanks Q—*i. e.*, tank No. 6—and having for its purpose to separate the solution from the pulp; V, a decanting-vat comprising a plurality of separate tanks designed to receive separate solutions from the filter U; W, one or more gold-tanks—*i. e.*, storage-tanks for the gold solution—arranged to receive from the vat V; X, one or more zinc boxes—*i. e.*, boxes arranged to receive from the tank or tanks W and filled with zinc shavings, on which the gold precipitates; Y, a sump-tank or plurality of tanks arranged to receive solution from the zinc box or boxes, and Z a centrifugal or other suitable pump connected with the sump tank or tanks and the tank J and designed to transfer the solution from the former to the latter. When the solution is thus returned to the tank J and cyanid is added thereto, the solution is used again. This materially lessens the cost of operating the apparatus and is advantageous for such reason.

The ore-crusher A, the elevator C, the grinding-rolls E and F, the elevator G, the pulverizer H, the counter-shaft P, the shafts, presently described, of the agitation-tanks Q, the sand-pump T, the filter U, and the pump Z are driven by a suitable motor or motors through the medium of suitable driving connections, which *per se* form no part of our invention and which we have therefore deemed it unnecessary to illustrate.

In the practical operation of our apparatus it will be observed that the solution is in contact with the ore incident to the grinding of the ore by the rolls E and F and incident to the reduction of the ore to a finely divided or comminuted state in the pulverizer H. By virtue of this and the subsequent violent agitation of the comminuted ore and solution in the tanks Q the solution reaches all of the values no matter how small the particles of ore in which the same are contained, with the result that when but a weak cyanid solution or other solvent is employed an extraction of from ninety-five per cent. to ninety-eight per cent. of values is effected in from two to six hours, and this without any subsequent concentration of the tailings. The reduction of the ore to a finely divided or comminuted state—*i. e.*, a pulverized state—in the presence of the solution employed assures the solution contacting with every particle of ore, as stated, and thereby accelerates the extraction of the values, and it is also advantageous since less power is required to grind wet ore than dry ore and because it does away with dust and lessens the wear and tear on the machinery. It will also be observed that the ore reduced to a pulverized state and the solution commingled therewith pass continuously and freely through the apparatus, which contributes materially to the thorough extraction of values from the ore. In this connection we desire it understood that we do not confine ourselves to the means shown and described for reducing the ore to a comminuted state in the presence of the solution employed, as any means may be employed for this purpose without involving a departure from the scope of our invention.

From the last of the agitation-tanks—*i. e.*, tank No. 6—the comminuted ore and solution pass to the filter U, where the solution is separated from the pulp and washes are applied to the latter to produce weaker solutions. The pulp is discharged from the filter as tailings, while the solutions separated from the pulp are piped or otherwise conducted to separate tanks of the vat V. Here the slimes in suspension are allowed to settle and are drawn off at the lower ends of the decanting-tanks, while the clear solution flows off at one end and adjacent to the top of the vat V and is led to the precipitating-tank.

Having described the general construction and operation of our improved apparatus, we will now proceed to a detailed description of the agitation-tanks Q, filter U, and decanting-vat V.

The tanks Q are similar in construction, and hence a detailed description of the one shown in Figs. 2 and 3 will suffice to impart an understanding of all. Referring therefore to Figs. 2 and 3, *a* is a cylinder fixed in the center of the tank Q and having a vent *b* adjacent to its upper end; *c*, a piston movable vertically in the cylinder and having a rod *d* extending through the upper end or head thereof; *e*, a shaft connected by a step *f* or other means with the rod *d*, so as to enable it to move vertically with and rotate independently of said rod *d*; *g*, a miter-gear to which the shaft *e* is keyed or feathered and through which said shaft is adapted to move vertically; *h*, a head connected to the shaft *e*, so as to turn and move vertically therewith; *i i*, agitating-blades connected together and to the head *h* and curved in the direction of their length and inclined in the direction of their width, Figs. 2 and 3, whereby they are adapted to throw the comminuted ore and solution outward after the manner of a centrifugal pump and upward like a plow; *j j*, stationary wings connected to the side wall of the tank and having for their purpose to force the mixture of comminuted ore and solution back to the center of the tank when the same is thrown outwardly by the blades *i*, and *k* a pipe let into the cylinder *a* below the piston *c* and designed, in common with the pipes *k* of the other cylinders Q, to be connected with a source of fluid-pressure supply. When the shaft *e* is rotated by a driving connection intermeshed with the miter-gear *g*, it will be observed that the material in the tank will be thrown outwardly and upwardly against the

wings *f*, which will roll it back into the center of the tank. This is materially advantageous, since in addition to being kept in suspension the material is worked up and down, and consequently the cyanid solution is caused to absorb the necessary oxygen and effect a rapid and complete dissolution of the gold and silver contained in the ore.

It is desirable in the event of a stop in the operation to raise the agitator means—that is, the blades *i* and the parts to which they are connected—of the several tanks Q out of the mixture or pulp therein. This, in virtue of our improvements, may be accomplished by an attendant opening a valve (not shown) controlling communication between a source of fluid-pressure supply and the pipes *k*, for it will be seen that when fluid-pressure is let into the cylinders *a* of the tanks Q the pistons *c*, shafts *e*, and agitators *i* of said tanks will be raised. To lower the agitators into the mixture or material in the several tanks, the attendant has but to open a bleeder (also not shown) connected with the pipes *k*, when the agitators will gravitate or settle down into the working position. (Shown in Fig. 2.)

It will be appreciated from the foregoing that both the raising and lowering of the agitators in the tanks Q may be quickly and easily effected without involving effort on the part of the attendant of the apparatus, which is a desideratum.

The filter U is best shown in Figs. 4 to 7, referring to which *l* is the main frame of the filter, which preferably comprises a base and two longitudinal uprights and is provided at the upper sides of the latter with parallel longitudinal ways *m*, Figs. 5 to 7; *n n*, transverse shafts journaled in the uprights of the frame at the ends thereof and equipped with sprocket-wheels *p*, arranged in alinement with the ways *m*; *r r*, sprocket-chains mounted on the wheels *p* and having their upper stretches disposed in the ways *m*; *s*, an endless filter-cloth; *t t*, endless strips of rubber or other suitable material secured to the inner side of the cloth *s* at the edges thereof and having for their purpose to bear on the upper edges of the longitudinal frame-uprights, and thereby prevent frictional wear of the cloth; *u u*, arms connected to the chains *r* at intervals in the length thereof and extending inwardly therefrom; *v v*, links which connect the filter-cloth and rubber belts to the arms *u*; *w w*, transverse rolls of wood or other suitable material mounted in the frame-uprights below the upper stretch of the filter-cloth and arranged, by preference, in three sets, as best shown in Fig. 4; *x x*, idler sprocket-wheels disposed above and in engagement with the upper stretches of the chains *r* and having for their purpose to hold the chains down on sprocket-gears *y* on the rolls *w*, so as to assure the rotation of the rolls in the direction indicated by arrow by the chains; *z z*, transverse rolls arranged in three sets above the rolls *w* and the upper stretch of the filter-cloth *s* and designed to be pressed by screws *a'* or other means toward the filter-cloth; *b b'*, rolls, one of which is employed in conjunction with each set of rolls *z*; *c c'*, screws, the purpose of which is to hold the upper bearing-blocks of the rolls *b'* on the lower slidable bearing-blocks thereof; *d' d'*, screws for adjusting the bearings of the rolls *b'* in the direction of the length of the filter and adjustably fixing the same in position; *e' e'*, belts of rubber or other suitable material passed around the rolls *z* and *b'* and having their lower stretches arranged in frictional contact with the filter-cloth *s*; *f' f'*, receptacles arranged under the three sets of rolls *w* and designed to be connected by pipes *g'* with the separate decanting-tanks of the vat V; *h' h'*, pipes designed to be connected with a source of water-supply and arranged to spray water against the stretches of the rubber belts *e'* between the filter-cloth *s* and the rolls *b'*; *i' i'*, pipes arranged to spray water against the lower stretch of the filter-cloth *s*; *j'*, a rotary beater arranged adjacent to the pipes *i'* and adapted to engage the lower stretch of the cloth *s*; *k'* a transverse roller arranged above the lower stretch of the cloth *s* and adjacent to the beater and having its ends journaled in disks *l'* off the center thereof, the disks being arranged in straps *m'* and provided with handles *n'*; *p'*, a transverse roll arranged below the lower stretch of the cloth *s*; *q'*, a weighted transverse roll arranged above the lower stretch of the cloth *s* and having for its purpose to squeeze the same against the roll *p'*, and *r'* a rotatable spreader arranged above the upper stretch of the cloth *s* at the receiving end of the filter. One of the shafts *n* of the filter is designed to be driven by a suitable motor, (not shown,) while the beater *j'* is preferably driven from an overhead counter-shaft. (Also not shown.)

The operation of the filter U in detail is as follows: The chains *r* and filter-cloth *s* are driven in the direction indicated by arrow and the beater *j'* is rotated. The rubber belts *e'* are driven in the direction indicated by arrow by the friction between them and the filter-cloth. The pulp and solution are discharged from the last agitation-tank—*i. e.*, tank No. 6—through pipe R into the spreader, which has flights extending right and left from the center and is consequently adapted to keep the pulp and solution mixed and spread the same uniformly across the filter-cloth. The filter-cloth carries the mixed pulp and solution under the first set of press-rolls *z*, where the first rubber belt *e'* presses the solution through the filter-cloth. This solution, which is strong, is received in the first receptacle *f'* and is carried by the pipe *g'* to one of the decanting-tanks of the vat V. As it leaves the first set of press-rolls most of the pulp adheres to the first belt *e'*. It is, however, washed down to the cloth by the spray of water from the adjacent pipe *h'*,

which also dilutes the values left as moisture in the pulp. The mixed pulp and water then passes under the second set of press-rolls z, where the second belt e' passes the solution, which is of medium strength, through the filter-cloth. This solution is received in the second receptacle f' and conducted by the pipe g' thereof to a tank of the vat V separate from that in which the first solution is placed. In leaving the second set of press-rolls the pulp is watered by the pipes h' adjacent to the second belt e', and the pulp and water are carried below the third set of press-rolls. Here the weak solution, produced by the mixture of pulp and water, is pressed through the cloth s and received in the third receptacle f', from whence it is conducted by the pipe g', complementary to said receptacle, to a separate tank of the vat V. After leaving the third set of press-rolls the pulp is forced from the cloth by the water discharged by the pipes i' and the beater j' and is discharged as tailings from the filter through a launder a^3, which may extend to a dump or any other point. After being acted on by the beater j' the cloth s passes between the squeeze-rolls p' q', which serve to press the water from the cloth, with the result that the same returns to the receiving end of the filter in a clean and dry state. By turning the disks l', and thereby raising or lowering the roller k', the filter-cloth is carried toward or from the beater j' to increase or diminish the action of the beater on the cloth.

It will be readily appreciated from the foregoing that the construction of our improved filter is such that the slimes are effectually prevented from collecting and packing down on the filter-cloth and preventing the passage of the solutions therethrough, also that by virtue of the chains traveling in ways or grooves in the frame and being connected to the filter-cloth the filter-cloth is spread out and always held in proper position with respect to the press-rolls and belts e', which conduces to the thorough separation of the solution from the pulp.

As best shown in Fig. 8, the vat V is divided by transverse partition-walls a^3 into a plurality of separate decanting-tanks a^4. These tanks are designed to receive the solutions from the receptacles f' of the filter U, and each of them is provided at its lower end with a steep funnel a^5, which is provided in turn at its lower end with a hose a^6. The hose of each tank is normally closed by a clamp, Fig. 9, which comprises a fixed member a^7, connected to the funnel and disposed at one side of the hose, and a pivoted member a^8, connected to the funnel and disposed at the opposite side of the hose with reference to the member a^7 and normally held in the position shown by a weight a^9. When the solutions from the filter U are led into the tanks a^4 of the vat V, the slimes settle into the funnels a^5 and are drawn off at intervals into a trough a^{10}, while the clear solution passes through one or more conduits a^{11} at one end of the vat to the gold-tank W. When desirable, the members a^8 of the clamps of the several tanks a^4 may be connected together, so that all of the clamps may be opened in concert and slimes discharged from all of the tanks at one time.

The construction described for controlling the discharge of slimes from each of the decanting-tanks is materially advantageous, since there is no liability of the pulp choking the hose, the opening and closing of the hose serving to keep the pulp loose.

We prefer in practice to use a pump M^7 and a conduit M^9 to return the slimes discharged from the tanks a^4 to the lowermost of the agitation-tanks or to the filter, this in order to pass the slimes through the filter the second time and recover the solution contained therein. The conduit M^9 preferably leads from the receptacle or trough a^{10} to the pump M^7 and thence to the lowermost agitation-tank, as shown in Fig. 1.

It will be appreciated from the foregoing that in virtue of the fine grinding our improved apparatus will treat to advantage high or low grade pyritic and telluride ores without a preliminary roast, as the fine grinding frees the particles of gold inclosed in the pyrites and renders the telluride and other compounds of gold more amenable to the cyanid solution.

The spreader r' is arranged in a box r^2, which preferably has an apron r^3. The spreader is a six-sided shaft having wooden flights or wings r^{10} on its sides, the wings at one side of the center of the shaft being inclined oppositely to those at the opposite side of the center. The spreader is driven by belt from an overhead counter-shaft. (Not shown.)

We have entered into a detailed description of the construction and relative arrangement of the parts embraced in the present and preferred embodiment of our invention in order to impart a full, clear, and exact understanding of the same. We do not desire, however, to be understood as confining ourselves to such specific construction and relative arrangement of parts, as such changes or modifications may be made in practice as fairly fall within the scope of our invention as claimed.

Having described our invention, what we claim, and desire to secure by Letters Patent, is—

1. In an apparatus for extracting precious metals from their ores, means whereby ore is reduced to a finely-divided or comminuted state in the presence of a solvent, a series of overflow-tanks arranged to receive the mixed ore and solvent from the reduction means; said tanks containing means for agitating the ore and solvent, and a filter arranged to receive the mixed ore and solvent from the last of the overflow-tanks, and adapted to separate the solution from the ore.

2. In an apparatus for extracting precious metals from their ores, means for reducing ore to a finely-divided or comminuted state, means for supplying a cyanid or other suitable solution to the ore incident to the said reduction thereof, a series of overflow-tanks arranged to receive the mixed ore and solution from the reduction means, and equipped with means for agitating the ore and solution, means for supplying solution alone to the first of said tanks, and a filter arranged to receive the mixed ore and solution from the last of the tanks, and adapted to separate the solution from the ore.

3. In an apparatus for extracting precious metals from their ores, the combination of a tank for containing a cyanid or other suitable solution, means for reducing ore to a finely-divided or comminuted state, one or more conduits connected with the solution-tank and arranged to supply the ore with solution incident to the reduction thereof, means for agitating and mixing the ore and solution, arranged to receive the same from the reduction means, a filter arranged to receive the ore and solution from the agitating and mixing means, and adapted to separate the solution from the ore, one or more decanting-tanks arranged to receive the solution or solutions from the filter, a precipitating-tank which receives the clear solution from the decanting tank or tanks, and means for transferring the solution from the precipitating-tank back to the solution-tank.

4. In an apparatus for extracting precious metals from their ores, the combination of an ore-bin, an ore-feeding device controlling the discharge of the bin, means for reducing ore to a finely-divided or comminuted state, arranged to receive from the bin, a tank for containing a cyanid or other suitable solution, a conduit connected with said tank and arranged to supply the ore with solution incident to the reduction thereof, a measuring device controlling said conduit, and a common means for actuating the ore-feeding device and the solution-measuring device.

5. In an apparatus for extracting precious metals from their ores, the combination of an ore-bin, an ore-feeding device controlling the discharge of the bin, means for reducing ore to a finely-divided or comminuted state, arranged to receive from the bin, a tank for containing a cyanid or other suitable solution, a conduit connected with said tank and arranged to supply the ore with solution incident to the reduction thereof, a measuring device controlling said conduit, a common means for actuating the ore-feeding device and the solution-measuring device, a series of overflow-tanks containing means for agitating and mixing the ore and solution, a conduit for conveying solution to the first of the overflow-tanks, a pump arranged to raise ore and solution from the reduction means to the first of the overflow-tanks, a filter arranged to receive ore and solution from the last of the overflow-tanks, and separate the solution from the ore, one or more decanting-tanks arranged to receive a solution or solutions from the filter, a precipitating-tank which receives the clear solution from the decanting tank or tanks, and means for transferring the solution from the precipitating-tank back to the solution-tank.

6. In an apparatus for extracting precious metals from their ores, the combination of an ore-bin, means for reducing ore to a crushed state, arranged to receive from the bin, means for controlling the discharge of ore from the bin, a tank for containing a cyanid or other suitable solution, a conduit connected to the tank and arranged to supply the ore with solution incident to the reduction thereof, means for controlling the passage of solution through said conduit, and a common means for operating the means for controlling the discharge of the ore from the bin, and the means for controlling the passage of the solution through the conduit, whereby the supply of solution is commensurate with the supply of ore.

7. In an apparatus for extracting precious metals from their ores, means whereby ore is reduced to a pulverized state in the presence of a solvent, means for agitating the mixed ore and solvent, means for separating the solution from the ore, decanting means for receiving the solution from the separating means, and a precipitating-tank for receiving solution from the decanting means.

8. In an apparatus for extracting precious metals from their ores, a solvent source of supply, means whereby ore is reduced to a pulverized state in the presence of solvent from the source of supply, means for agitating the mixed ore and solvent, means for separating the solution from the ore, decanting means for receiving the solution from the separating means, a precipitating-tank for receiving solution from the decanting means, and means for conducting the solution to the source of supply.

9. In an apparatus for extracting precious metals from their ores, means for separating solution from ore, decanting means receiving solution from the separating means, and means for returning slimes from the decanting means to the separating means.

10. In an apparatus for extracting precious metals from their ores, the combination of means for separating solutions from mixed ore and solvent, and separate decanting devices for receiving the solutions from the separating means.

In testimony whereof we have hereunto set our hands in presence of two subscribing witnesses.

JOHN STOVEKEN.
LEO STOVEKEN.

Witnesses:
WM. H. TABOR,
JAMES A. MCCANDLESS.

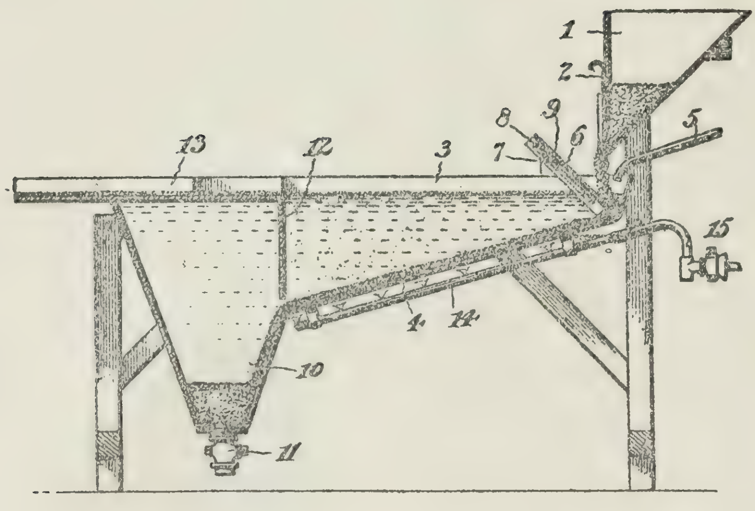
No. 735,071. PATENTED AUG. 4, 1903.

G. D. DELPRAT.

EXTRACTION OF ZINC, LEAD, AND SILVER SULFIDS FROM THEIR ORES.

APPLICATION FILED JAN. 3, 1903.

NO MODEL.



Witnesses
R. J. Ober
M. E. Beall

Inventor.
Guillaume Daniel Delprat.
by Henry Orth Jr.
Atty.

UNITED STATES PATENT OFFICE

GUILLAUME D. DELPRAT, OF BROKEN HILL, NEW SOUTH WALES, AUSTRALIA.

EXTRACTION OF ZINC, LEAD, AND SILVER SULFIDS FROM THEIR ORES.

SPECIFICATION forming part of Letters Patent No. 735,071, dated August 4, 1903.

Application filed January 2, 1903. Serial No. 137,586. (No specimens.)

To all whom it may concern:

Be it known that I, GUILLAUME DANIEL DELPRAT, general manager of the mines and works of the Broken Hill Proprietary Company, Limited, of Victoria, a subject of the Queen of the Netherlands, residing at Broken Hill, in the State of New South Wales and Commonwealth of Australia, have invented new and useful Improvements in the Extraction of Zinc, Lead, and Silver Sulfids from Their Ores, of which the following is a specification.

This invention relates to the extraction or concentration of sulfid ores to separate them from their gangue.

The ore is first finely ground or stamped and then immersed or dropped into a bath or solution, hereinafter described. An apparatus for carrying out the process forms the subject-matter of a separate application, filed March 9, 1903, Serial No. 146,895. This process is readily carried out at ordinary temperatures and depends upon the ore particles being attacked by the acid to form a gas. Each ore particle so attacked will have a bubble or bubbles of gas adhering to it, by means of which it will be floated and can be skimmed or floated off the solution. The particles of the gangue, such as silicates and other substances not quickly or readily attacked by acid or dilute acid, fall to the bottom of the body of the solution and are removed from time to time. To facilitate the floating of the ore particles, suitable salts are added to the solution to increase its specific gravity, as will be hereinafter explained.

In extracting or concentrating, more especially the sulfid ores of zinc, lead, and silver, I make use of a nitric-acid solution, the gravity of which is increased to one and four-tenths, (1.4,) more or less, by the addition of a suitable nitrate, such as an alkaline-metal nitrate, as the nitrate of soda, nitrate of potash, or another metallic nitrate, as the nitrate of zinc dissolved in water, or a mixture of nitrates. The sulfids in the ore are rapidly acted upon by the acid and gas-bubbles formed on them, that quickly carry them to the surface, whence they flow away or are removed by skimming. The tailings or waste may be removed from the bath from time to time, as is necessary or expedient.

The drawing shows in vertical longitudinal section the apparatus used.

Below an ordinary bin or hopper 1, having a regulating discharge-door 2, is the pan or vessel 3, having a sloping bottom 4. The liquor or chemical solution is supplied by pipe 5 from a suitable reservoir (not shown) at an upper level. Just below the door 2 is a plate 6 on pintles or pivots 7 in slots 8, adapted to be clamped by set-screws 9 when the plate is adjusted to the required angle and with the required extent of opening between the lower edge of said plate 6 and the bottom 4, the directing-plate being, primarily, to insure the total immersion of all particles of ore in the fluid or liquor. At the lower end of the inclined bottom 4 is a tailings-receiver or sump 10, having a tailings-discharge 11. At the receiving end of the sump 10 is a baffle-plate 12, extending close to the face of said bottom 4, the object of which is to prevent accumulation of concentrates above the sump 10. Extending from the pan 3 is a launder or trough 13 to receive the overflow and the concentrates. Under the bottom 4 is a piping 14, forming, with the air-inlet cock 15, a Bunsen burner for gas, so that the solution or liquor may be heated, if desired. The ore fed from the hopper 1 drops into the bath and slides by gravity over the bottom to the sump, the ore particles being raised to the surface of the liquor by the gas-bubbles formed, the action of the acid on these ore particles during their travel along the inclined bottom and ore floated off with the overflow through the trough 13, or, if desired, skimmed off.

Having thus described my invention, what I claim as new therein, and desire to secure by Letters Patent, is—

1. The method of separating ores from gangue, which consists in forming a bath containing nitric acid, feeding finely-ground ore thereto, whereby gas-bubbles will be formed on the ore particles to raise them to the surface of the solution, and removing the particles of ore so lifted to the surface, substantially as described.

2. The method of separating ores from gangue, which consists in forming a bath containing nitric acid and a suitable nitrate, feeding finely-ground ore thereto, whereby gas-bubbles will be formed on the ore particles to lift them to the surface and removing the ore particles so raised, substantially as described.

3. The method of separating sulfid ores from their gangue, which consists in forming a bath containing nitric acid, increasing the gravity of the bath by adding thereto the nitrate of an alkaline metal, whereby gas-bubbles will be formed on the ore particles to raise them to the surface, and floating off the particles of ore so raised to the surface, substantially as described.

4. The method of separating sulfid ores from their gangue, which consists in forming a bath containing nitric acid, adding thereto sodium nitrate to increase the specific gravity of the bath, feeding the finely-ground ore into the bath, whereby gas-bubbles will be formed on the surface of the ore particles to raise them to the surface of the bath and floating off the ore particles so raised, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

GUILLAUME D. DELPRAT.

Witnesses:

FRED WALSH,

PERCY NEWELL.

No. 736,381 PATENTED AUG. 18, 1903.

M. F. R. GLOGNER.

PROCESS OF PURIFYING GRAPHITE.

APPLICATION FILED JAN. 27, 1903.

NO MODEL.

Fig. 1.

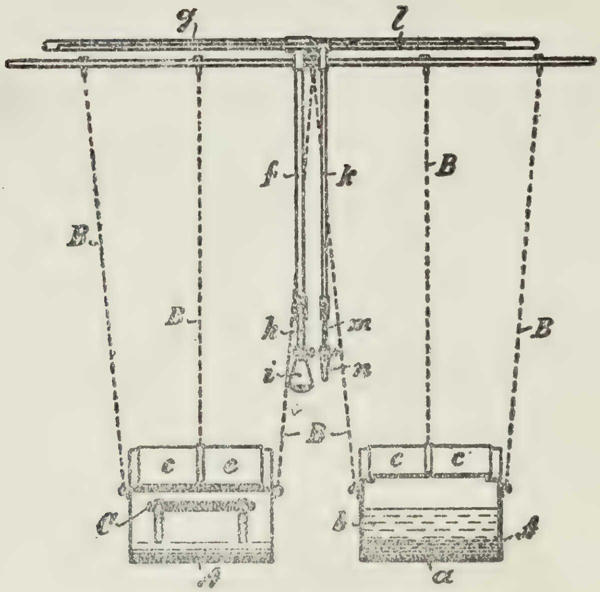
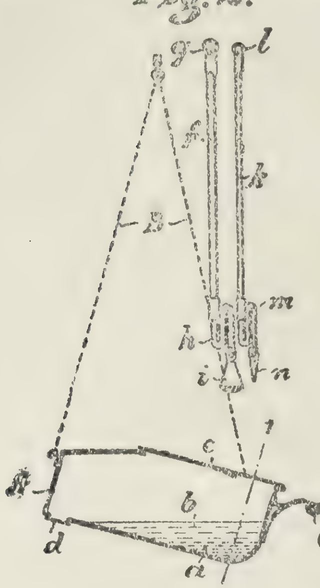


Fig. 2.



Witnesses

H. M. Kuehne

Paul Neubert

Inventor

C Moritz Friedrich Reinhold Glogner

By Richards & Co

Attorneys

No. 736,381. Patented August 18, 1903.

UNITED STATES PATENT OFFICE.

MORITZ FRIEDRICH REINHOLD GLOGNER, OF FREIBURG, GERMANY.

PROCESS OF PURIFYING GRAPHITE.

SPECIFICATION forming part of Letters Patent No. 736,381, dated August 18, 1903.

Application filed January 27, 1903. Serial No. 140,786. (No specimens.)

To all whom it may concern:

Be it known that I, MORITZ FRIEDRICH REINHOLD GLOGNER, a subject of the King of Prussia, German Emperor, residing at Freiburg, in the Kingdom of Prussia, German Empire, have invented certain new and useful Improvements in Processes of Purifying Graphite; and I do hereby declare that the following is a full, clear, and exact description.

The present invention relates to a process for purifying graphite from its natural mineral impurities, which process is especially adapted to be carried out on a manufacturing scale, because, on the one hand, it is very simple and cheap, and, on the other hand, the final result is very good and far superior to any obtainable by processes hitherto employed.

In my new process after being purified in a first wash from its heavier impurities—as, for instance, quartz, iron, and the like—by means of cold water the graphite mineral is mixed with about three or four times its weight of water to a thin paste. A quantity of petroleum is then added to this paste, which quantity is about half as much as the amount of pure graphite contained in the graphite mixture, and the whole is thoroughly stirred within a closed vessel. Afterward the vessel is allowed to stand, and water is sprinkled over the surface of the liquid by means of a rose or the like in order to obtain a quicker and more complete separation of the graphite particles from the earthy admixtures.

In my present invention I desire first to point out that the graphite mixture as submitted to the process of purification by means of water and petroleum consists, exclusively, of graphite and earthy admixtures. Only by this means is the quick and complete purification of the graphite by means of the subsequent treatment rendered possible. If the graphite were to be purified by means of water and petroleum while the heavier admixtures are still present, a far greater amount of petroleum, as well as of labor, would be necessary, yet a complete separation of the graphite from its admixtures would be impossible. The product obtained thus would not be pure. The high degree of purity, however, determines the value of the product.

For carrying out my new process preferably a plurality of agitating or shaking devices are arranged close to each other, one workman being sufficient for attending four of them.

Figure 1 of the accompanying drawings illustrates two agitating devices arranged close to each other, one apparatus being shown in elevation and the other in a section on line 1 1 in Fig. 2. Fig. 2 represents a longitudinal section of an agitating apparatus.

Each agitator A is obliquely suspended on three chains B in such a manner that the wave formed when the vessel is agitated falls back on the higher part of the bottom and a thorough mixing of oil and graphite is obtained, the operation being at the same time facilitated. Each vessel A has a handle C.

a is graphite filled in a wet state.

b is the water with the layer of oil.

c c are covers.

d is an outlet-hole for the pulpy residue—for instance, a hand-hole with a cover, a door, or the like. The tube *f* is in connection with a water-supply *g* and fitted with a flexible tube *h* and a rose *i*. The tube *k* is connected with an oil-supply *l* and also fitted with a flexible tube *m*, leading to a mouthpiece *n*.

The devices are preferably operated by human force, because the treatment of the material is utterly difficult, and a throughout special treatment is required for each of the large number of varieties of the material.

Before the graphite is brought into the vessels A it is separated from its heavier admixtures—as quartz, iron, and the like—which in the well-known manner is effected by washing the material with water in long kennels. Exactly-weighted quantities of the material which thus contains only graphite and earthy admixtures are brought into the vessels A. Then, first water is admitted from the tube *h* and later oil from the tube *m*.

The vessels A are agitated in short shocks, about thirty per minute. After the agitation has taken place the mixture of oil and graphite floating at the surface is subjected to a uniform action of the rose, whereafter the vessel is allowed to stand in order to obtain the separation of the earthy parts. After the attendant has operated four agitators in the described manner the dirty water in the first vessel has become clear in the meantime. The workman takes off the oil-graph-

ite and puts it into a collector for the further treatment in order to obtain in any well-known manner a separation of the oil from the graphite.

The mixture containing only fine earthy substances and graphite is mixed with a quantity of water the weight of which is about three or four times as great as that of the graphite mixture. Petroleum is then added in the approximate proportion of one part petroleum to two parts of graphite contained in the mixture. Now the whole is given a strong rotating, rocking, or reciprocating movement within a closed vessel, so that the mixture is thoroughly stirred and intimately mingled. The petroleum is broken up into very fine drops or perles, and every graphite particle when touching them is attracted, while the earthy particles, which were already saturated with water before the addition of petroleum, remain completely neutral. After the vessel has been allowed to stand the earthy parts sink down, while the petroleum carrying the graphite tends to rise to the surface. After a certain time water is then sprinkled over the surface of the liquid by means of a rose or the like, whereby the fine earthy particles are caused to sink more quickly, and any earthy particles which may be carried upward by the rising petroleum and froth are caused to sink down again.

The vessel is shaken once, twice, or repeatedly after the graphite has been skimmed, and every time some petroleum is added. The whole of the graphite will then be taken off by the petroleum.

In the described manner the graphite is quickly, well, and cleanly separated from its earthy admixtures. The product obtained is of best quality and purity, yet the amount of petroleum and labor needed is insignificant. It is even rendered possible by my process to work graphite mixtures which only contain ten per cent. graphite and to obtain from them a product which is as valuable as the Ceylon graphite.

My new process is furthermore especially adapted for the purification of the small dense crystalline varieties of graphite, for which a commercial purifying process has not existed up to the present time.

Having now described my invention and in what manner the same is to be performed, what I claim, and desire to secure by Letters Patent, is—

A process for purifying graphite in a wet and cold manner by the use of water and petroleum, consisting in the following operations. purifying the graphite mineral from its heavy admixtures (as for instance quartz, iron and the like) by a washing with cold water; mixing said purified graphite mineral with about three or four times its weight of cold water; very strongly agitating said paste within a closed vessel after the addition of a quantity of petroleum of about half the weight of the pure graphite contained in the mixture; and then sprinkling water over the surface of the liquid, after the mixture has been allowed to stand, in order to obtain a quicker and more complete separation of the graphite particles from the earthy substances, substantially as described.

In witness whereof I have hereunto set my hand in presence of two witnesses.

MORITZ FREIDRICH REINHOLD GLOGNER.

Witnesses:
ERNST. KRATZ,
ALBERT SCHENK.

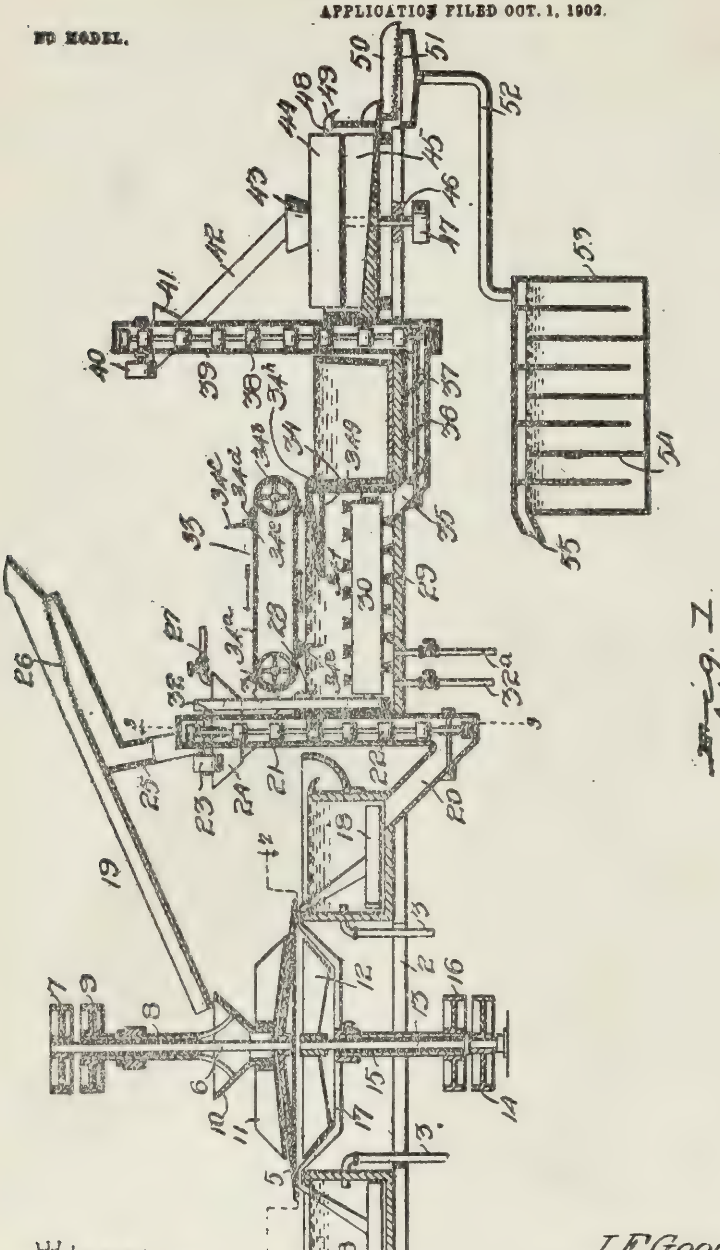
No. 745,960. PATENTED DEC. 1, 1903.

I. F. GOOD.

APPARATUS FOR SEPARATING GRAPHITE OR OTHER MATERIALS FROM ASSOCIATED IMPURITIES.

APPLICATION FILED OCT. 1, 1902.

NO MODEL. 3 SHEETS—SHEET 1.



Witnesses:

I. F. Good, Inventor

by C. A. Snow & Co. Attorneys.

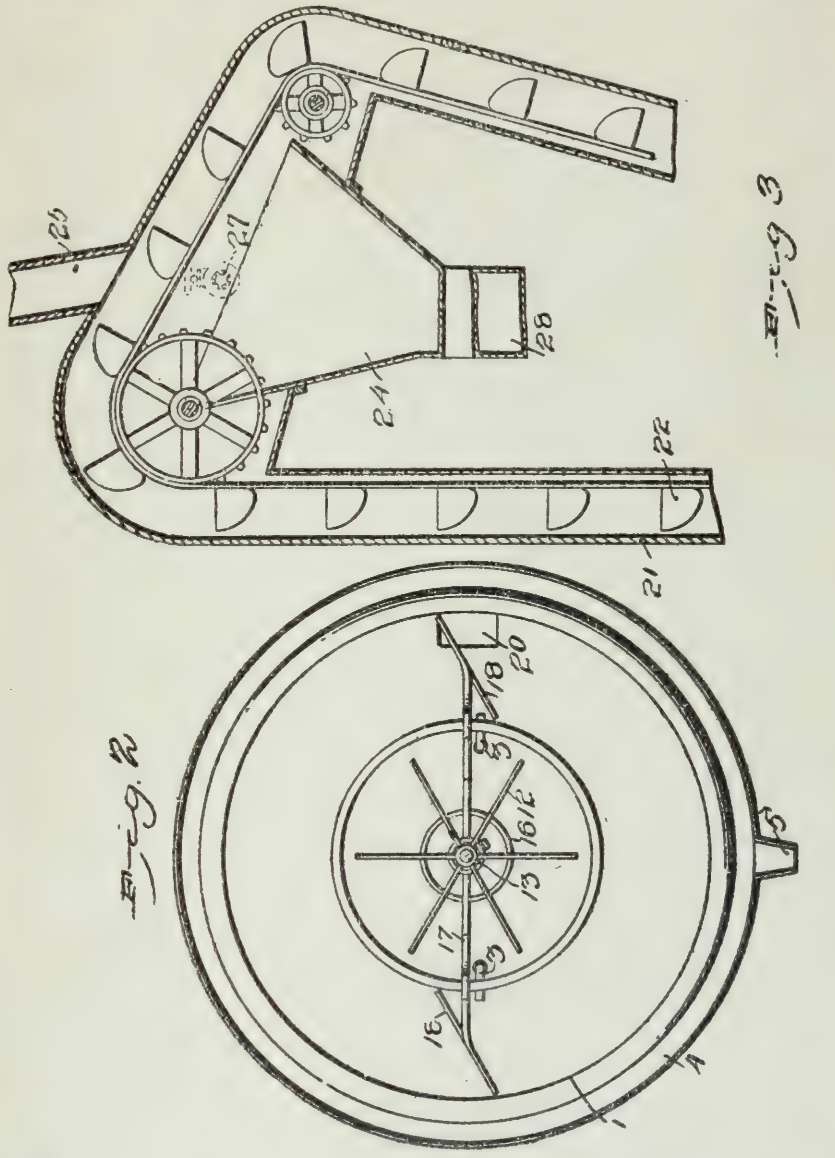
No. 745,960. PATENTED DEC. 1, 1903.

I. F. GOOD.

APPARATUS FOR SEPARATING GRAPHITE OR OTHER MATERIALS FROM ASSOCIATED IMPURITIES.

APPLICATION FILED OCT. 1, 1902.

NO MODEL. 2 SHEETS—SHEET 2.



Witnesses:
E. J. Stewart
R. M. Elliott.

I. F. Good, Inventor:
by C. A. Snow & Co. Attorneys.

No. 745,960. Patented December 1, 1903.

UNITED STATES PATENT OFFICE.

ISRAEL F. GOOD, OF ALLENTOWN, PENNSYLVANIA, ASSIGNOR OF ONE-HALF TO GEORGE FRANCIS PETTINOS, OF BETHLEHEM, PENNSYLVANIA, AND JOHN HERBERT HARRIS, OF ALLENTOWN, PENNSYLVANIA.

APPARATUS FOR SEPARATING GRAPHITE OR OTHER MATERIALS FROM ASSOCIATED IMPURITIES.

SPECIFICATION forming part of Letters Patent No. 745,960, dated December 1, 1903.

Application filed October 1, 1902. Serial No. 125,532. (No model.)

To all whom it may concern:

Be it known that I, ISRAEL F. GOOD, a citizen of the United States, residing at Allentown, in the county of Lehigh and State of Pennsylvania, have invented a new and useful Apparatus for Separating Graphite or other Materials from Associated Impurities, of which the following is a specification.

This invention relates to an apparatus for separating graphite and other materials from associated impurities.

The object of the invention is in a ready, simple, rapid, thoroughly-feasible, and practical manner initially to separate pure graphite from any associated impurities and conserve it and then to effect saving of the bulk of whatever remains in the impurities separated out.

With these and other objects in view, as will appear as the nature of the invention is better understood, the same consists in the novel construction and combination of parts of an apparatus for separating graphite and other materials from associated impurities, as will be hereinafter fully described and claimed.

In the accompanying drawings, forming a part of this specification, and in which like numerals of reference indicate corresponding parts, there is illustrated one form of embodiment of the invention capable of carrying the same into practical operation, it being understood that the elements therein exhibited may be varied or changed as to shape, proportion, and exact manner of assemblage without departing from the spirit thereof.

In the drawings, Figure 1 is a view in vertical longitudinal section through an apparatus constructed in accordance with the present invention. Fig. 2 is a view in longitudinal section taken on the line 2 2 of Fig. 1 and looking in the direction of the arrow thereon. Fig. 3 is a view in sectional elevation, on an enlarged scale, taken on the line 3 3, Fig. 1, showing more particularly the conveying mechnism for elevating the impure materials from the primary separating-tank to the washing mechanism.

Referring to the drawings, 1 designates an annular tank constituting the primary separating-tank, the same being suitably supported upon a bed 2 and containing water supplied thereto by the pipes 3. The upper portion of the tank is surrounded by a trough 4, having a discharge-spout 5. (Clearly shown in Fig. 2.) Disposed above the tank, with its periphery overlapping the inner walls thereof, is an upward-dished disk 5, which is rigidly mounted upon a shaft 6, driven from a pulley 7 through a belt, (not shown,) and inclosing the shaft 6 is a tubular shaft 8, carrying at its upper end a pulley 9 and at its lower end a hopper 10 and a fan 11, the latter being disposed over the disk and rotating in a direction opposite thereto. The fan 11 produces a current of air which is mainly directed horizontally outward, but of which a small portion is directed downward owing to the vertical divergence of the blast, so producing a slight downward pressure upon the upwardly-dished disk 5, the utility of which will be hereinafter explained. Disposed below the disk is a second fan 12, rigidly secured to a shaft 13, driven by a pulley 14, and inclosing the shaft 13 is a tubular shaft 15, carrying at its lower end a pulley 16 and at its upper end a pair of arms 17, which are bent to project downward into the tank and carry at their terminals scrapers or stirrers 18.

Disposed over the hopper 10 is a chute 19, down which the finely-powdered rock, sand, or earth containing the graphite or other materials is fed. Thence it passes into the hopper and down upon the disk 5, where the finer particles or flakes of graphite are retained by the slight downward pressure of the blast of air from the fan 11, while the coarser portions drop into the tank 1. The flakes caught by the disk 5 under centrifugal action due to the rotation of the disk are discharged outward and upon the surface of the water contained in the tank, this action being assisted by the blast of air from the fan 12, which impinges the discharge of finely-divided graphite as it escapes in a sheet from the periphery of the disk and operates to spread it out over the water and also to impel it laterally to the trough 4, whence it es-

capes through the spout 5 and is caught in a suitable receptacle. The coarser portions of the graphite, rock, and sand or dirt mixed therewith are forced out of the tank and down an outlet 20, the scrapers 18, as shown in Fig. 2, being preferably disposed tangentially to their path of movement, thus to prevent the material from banking up against the inner wall of the tank, as will be readily understood. Communicating with the outlet 20 is a casing 21, housing an ordinary conveyer 22, driven from a pulley 23, and this conveyer elevates the material and discharges into a hopper 24. (Shown in detail in Fig. 3.) Communicating with the hopper is a spout 25, tapped into the chute 19, the mouth of the spout being covered by a fine screen 26 to effect separation of the finer particles of graphite which mix with the materials elevated by the conveyer 22. In the hopper the material has oil, either coal-oil or any other suitable kind, sprayed upon it from a pipe 27, and the mixed graphite, sand, &c., escapes through a chute 28 into a washing-tank 29, containing a rotary agitator 30, driven by a belt 31 from the upper shaft 32 of the conveyer 22, the water of the tank 29 being kept at boiling heat by steam supplied through pipes 32[a]. The lighter particles of graphite separated by the agitator and that float on the surface of the water in the washing-tank are removed by a skimming device 33 and are discharged into a tank 34, containing water, whence they are removed. The skimming device comprises a belt 34[a], supported by two pulleys 34[b], disposed in horizontal alinement above the tank 29, one of the pulleys being driven by any suitable means, not necessary to be shown. Secured at regular intervals to the belt are curved arms 34[c], which are in length equal to the width of the tank, which latter is rectangular in shape, the arms being hinged to keepers 34[d], secured to the belt, a spring 34[e], coacting with each arm, operating normally to cause it always to occupy a position at right angles to the belt, while permitting it to yield, as indicated by dotted lines. The tank has associated with the upper portion of its rear end an inclined plate 34[f], supported in the tank by a plate 34[g], the outer end of the plate 34[f] being projected over the upper edge of the tank to constitute a lip 34[h]. As the belt is rotated the arms or skimmer elements 34[c] travel along the upper surface of the material contained in the tank and convey it to the plate 34[f], up which it is pushed, the incline of the said plate operating to cause the arm to be folded inward toward the belt, as shown; but as soon as it passes the lip 34[h] the arm will resume its normal position.

The coarser portions of the graphite and any sand or the like remaining in the washing-tank pass down an outlet 35 into a conduit 36, in which is arranged a screw conveyer 37, which feeds the material to a second bucket conveyer 38, arranged in a housing 39, the conveyer being driven by a pulley 40, revolved by a belt, not necessary to be shown. The material elevated by the conveyer 38 is discharged into a hopper 41, thence passes through a chute 42 into the hopper 43 of a muller comprising two circular blocks of wood 44 and 45, the latter being stationary and the former being revolved by a shaft 46, driven by a pulley 47. The mulling-blocks are arranged within a tank 48, containing water and provided with a spout 49, which discharges into a trough 50, having a screen 51 to separate the sand, &c., from the graphite, the trough having connected with it a pipe or conduit 52, which connects with a settling-tank 53 of the usual construction. As the upper muller-block is rotated it operates to reduce the graphite to a pasty mass, which settles in the tank 53, whence it is removed, the tank being provided with the usual baffle-plates 54 common to such structures and with an overflow-spout 55.

The operation of this machine is extremely rapid and is continuous and effects in a thoroughly efficient and practical manner the separation of the graphite from any associated impurities.

Having thus described the invention, what I claim as new is—

1. An apparatus of the character specified, comprising a rotary receiving-table, and pneumatic means for holding the finer particles of graphite thereon while the coarser portions escape.

2. An apparatus of the character specified, comprising a rotary receiving-table, pneumatic means for holding the finer particles of graphite thereon while the coarser portions escape, and pneumatic means for impelling the finer particles laterally to a point of discharge.

3. An apparatus of the character specified, comprising an upward-dished receiving-table, a fan disposed above the table for holding the finer particles of graphite thereon while the coarser portions escape, and a fan disposed beneath the table for impelling the finer particles to a point of escape.

4. An apparatus of the character specified, comprising an annular tank, a rotary upward-dished receiving-table projecting over the tank, a fan disposed respectively above the table and rotating in the direction opposite that of the table, and rotary scrapers disposed within the tank.

5. An apparatus of the character specified, comprising means for separating the finer graphite from any associated impurities, means for conserving the finer particles, a washing-tank embodying agitating mechanism, means for conveying the residuum to the washing-tank, means for mixing oil with said residuum before being discharged into the washing-tank, a skimming device associated with the tank to remove the finer particles from the tank, a muller, means for convey-

ing the coarser particles from the washing-tank to the muller, and a settling-tank communicating with the muller.

6 An apparatus of the character specified, comprising an annular tank having a peripheral trough associated therewith, an upwardly-dished receiving-table having its periphery disposed over the tank, blast mechanism disposed above and below the table and rotating in a direction opposite thereto, a hopper associated with the upper blast mechanism, rotary stirrers disposed within the tank, a washing-tank, conveying mechanism communicating with the annular tank and discharging into the washing-tank, a chute for discharging the coarser portions of graphite to the hopper of the upper fan and the finer particles to the washing-tank, means for supplying oil to the mixed finer and coarser portions before entry into the washing-tank, agitating and skimming mechanism associated with the washing-tank, a muller, conveying mechanism communicating with the washing-tank and discharging into the muller, and a settling-tank in communication with the muller.

In testimony that I claim the foregoing as my own I have hereto affixed my signature in the presence of two witnesses.

ISRAEL F. GOOD.

Witnesses:
PETER G. CONRAD,
DAVID T. HISKEY.

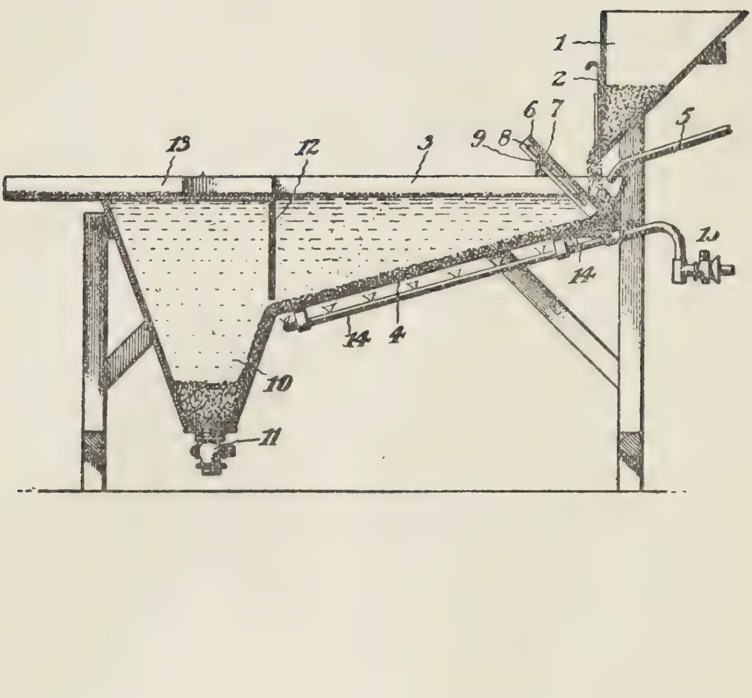
No. 768,035. PATENTED AUG. 23, 1904

G. D. DELPRAT.

EXTRACTING ZINC OR OTHER SULFIDS FROM THEIR ORES.

APPLICATION FILED JAN. 2, 1903.

NO MODEL.



Witnesses:
G. Ober

Inventor.
Guillaume Daniel Delprat

by

Atty.

No. 768,035. Patented August 23, 1904.

UNITED STATES PATENT OFFICE.

GUILLAUME D. DELPRAT, OF BROKEN HILL, NEW SOUTH WALES, AUSTRALIA.

EXTRACTING ZINC OR OTHER SULFIDS FROM THEIR ORES.

SPECIFICATION forming part of Letters Patent No. 768,035, dated August 23, 1904.

Application filed January 2, 1903. Serial No. 137,585. (No specimens.)

To all whom it may concern:

Be it known that I, GUILLAUME DANIEL DELPRAT, a subject of the Queen of the Netherlands, residing at Broken Hill, in the State of New South Wales and Commonwealth of Australia, have invented certain new and useful Improvements in Extracting Zinc or other Sulfids from Their Ores, of which the following is a specification.

The finely-divided ores are immersed in a hot but preferably not boiling solution of salt cake or of sodium sulfate and sulfuric acid, and the sulfids rise to the top and are skimmed off or otherwise removed.

A suitable apparatus for carrying out the process is shown in section in the accompanying drawing.

Below an ordinary bin or feed-hopper 1, having a regulating discharge-door 2, is the pan or vessel 3, having a sloping bottom 4. The liquor or chemical solution is supplied by pipe 5 from a suitable reservoir (not shown) at an upper level. Just below the door 2 is a plate 6 on pintles or pivots 7 in slots 8, adapted to be clamped by set-screws 9 when the plate is adjusted to the required angle and with the required extent of opening between the lower edge of said plate 6 and the bottom 4, the directing-plate being primarily to insure the total immersion of all particles of ore in the fluid or liquor. At the lower end of the inclined bottom 4 is a tailings-receiver or sump 10, having a tailings-discharge 11. At the receiving end of the sump 10 is a baffle-plate 12, extending close to the face of said bottom 4, the object of which is to prevent accumulation of concentrates above the sump 10. Extending from the pan 3 is a launder or trough 13 to receive the overflow and the concentrates. Under the bottom 4 is piping 14, forming with the air-inlet cock 15 a Bunsen burner for gas, so that the solution or liquor may be raised to any desired temperature. The ore fed from the hopper 1 drops into the heated bath and slides by gravity over the bottom to the sump, the ore particles being raised by the gas-bubbles to the surface of the liquor during the travel of the ore over the inclined bottom and are floated off with the overflow through the trough 13 or, if desired, skimmed off. This apparatus forms the subject-matter of a separate application for patent filed March 9, 1903, Serial No. 146,895, to which I therefore make no claim in this application.

In practice the "sulfid ores," including in such term the products and waste from other metallurgical processes, are finely pulverized, as well understood, and are then ready for immersion in the hot bath. This bath consists of a solution of salt cake in water of a specific gravity approximating to 1.4, (one and four-tenths,) which is kept hot, but preferably is not allowed to boil. As an alternative the bath consists of a solution of sodium sulfate in water, to which is added free sulfuric acid, so that the resultant will approximate the stated specific gravity of 1.4, (one and four-tenths,) and this bath is also kept heated and likewise preferably not allowed to boil. As the ore immerses itself in the heated bath the sulfids with gas-bubbles of sulfureted hydrogen attached disengage themselves from the gangue, rising to the top, whence they may flow away or be skimmed off. The tailings or waste may be removed from the bottom of the sump at intervals as desired.

Having thus described my invention, what I claim as new therein, and desire to secure by Letters Patent, is—

1. The method of separating ores from their gangue, which consists in forming an aqueous solution of an acid capable of reacting with the ore to form a gas and increasing the density of said solution by adding thereto a suitable substance, then feeding the mixture of ore and gangue to the solution, decreasing the density of the gas as it is formed on the ore particles, and removing the ore particles raised to the surface, substantially as described.

2. The method of separating ores from their gangue, which consists in forming a solution of a suitable acid capable of reacting with the ore to form a gas, increasing the density of the solution by adding thereto a suitable salt soluble therein, then feeding the mixture of ore and gangue to the solution and decreasing the density of the gas as it is formed, whereby

the size of gas-bubbles will be increased and the ore raised to the surface of the solution, substantially as described.

3. The method of separating ores from their gangue, which consists in forming a solution of an acid capable of reacting on the ore to form a gas, and increasing the density of said solution by a suitable substance, then feeding the finely-ground mixture of ore and gangue to the solution and finally removing the ore particles raised to the surface, substantially as described.

4. The method of separating sulfid ores from their gangue, which consists in forming a solution containing sulfuric acid, and adding thereto a substance soluble therein and capable of increasing the density of the solution, feeding fine ore thereto capable of reacting with sulfuric acid to generate a gas and thereby raise the ore to the surface, and removing the ore so raised to the surface, substantially as described.

5. The method of separating sulfid ores from their gangue, which consists in forming a solution of sulfuric acid and a sulfate, maintaining the solution heated below the boiling-point, feeding finely-ground ore thereto, whereby the acid will react with the soluble sulfid-ore particles present to form sulfureted hydrogen and be lifted by bubbles of said gas to the surface of the solution, and removing the ore so carried to the surface of the solution, substantially as described.

6. The method of separating sulfid ores from their gangue, which consists in forming a solution of sulfuric acid and sodium sulfate, maintaining the solution heated below the boiling-point, feeding finely-ground ore thereto, whereby the acid will react with the soluble sulfid-ore particles present to form sulfureted hydrogen and be lifted by bubbles of said gas to the surface of the solution, and removing the ore so carried to the surface of the solution, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

GUILLAUME D. DELPRAT.

Witnesses:
FRED WALSH,
PERCY NEWELL.

No. 771,075 PATENTED SEPT. 27, 1904

C. KENDALL.

SEPARATION OF MINERAL SUBSTANCES BY MEANS OF THE SELECTIVE ACTION OF OIL.

APPLICATION FILED JULY 21, 1903.

NO MODEL. 2 SHEETS—SHEET 1.

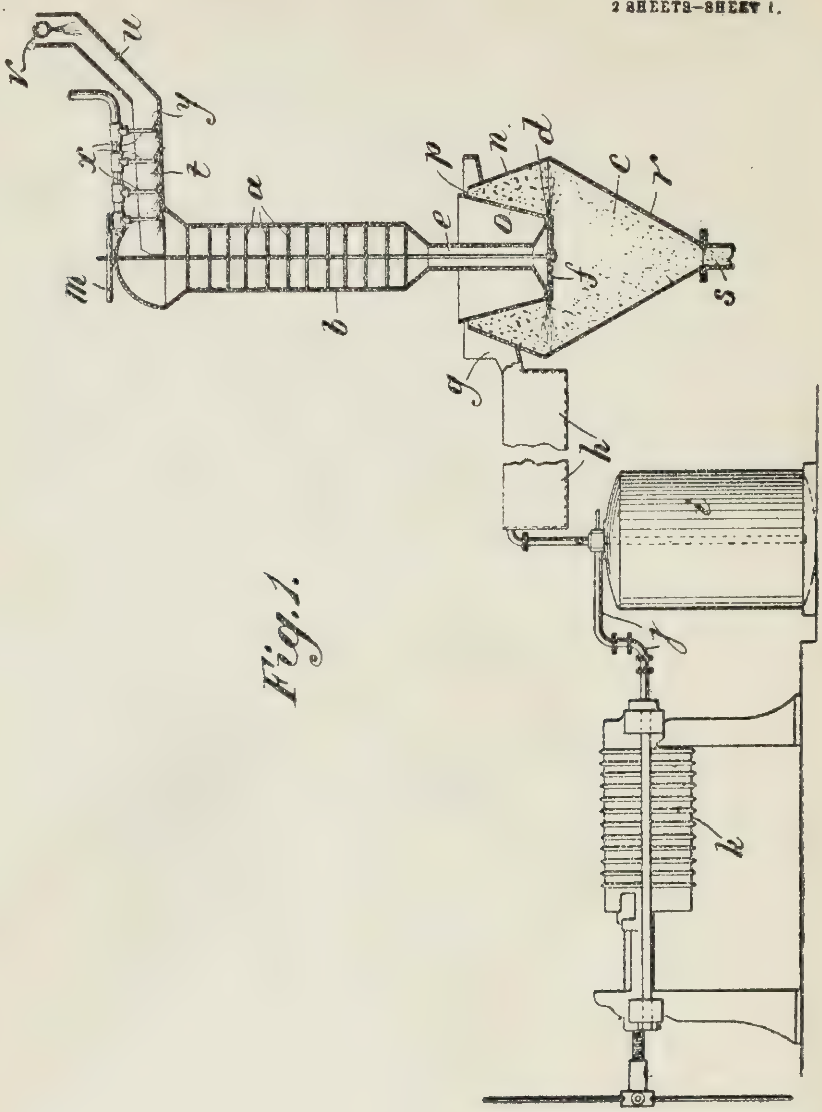


Fig. 1.

Witnesses

Chas. R. Wright Jr.

Alice W. Elmberg

Inventor

Cosmo Kendall

By A S Pattison,

Atty.

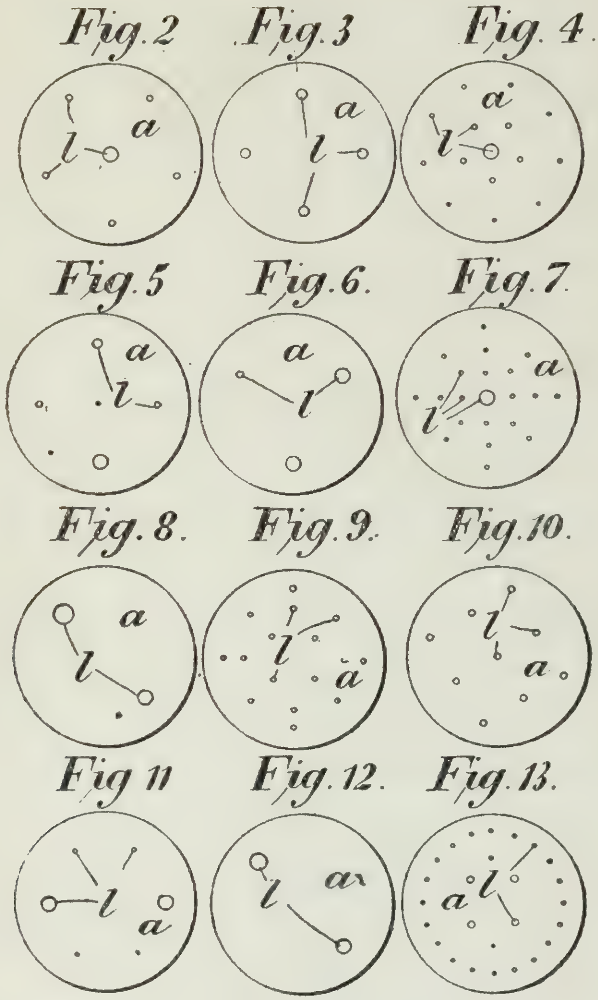
No. 771,075 PATENTED SEPT. 27, 1904

C. KENDALL.

SEPARATION OF MINERAL SUBSTANCES BY MEANS OF THE SELECTIVE ACTION OF OIL.

APPLICATION FILED JULY 21 1903.

NO MODEL. 2 SHEETS—SHEET 2.



Witnesses
Chas. F. Wright Jr.
Alice M. Eberling

Inventor
Cosmo Kendall
By A S Pattison,
Atty.

No. 771,075. Patented September 27, 1904.

UNITED STATES PATENT OFFICE.

COSMO KENDALL, OF UPPER NORWOOD, ENGLAND.

SEPARATION OF MINERAL SUBSTANCES BY MEANS OF THE SELECTIVE ACTION OF OIL.

SPECIFICATION forming part of Letters Patent No. 771,075, dated September 27, 1904.

Application filed July 21, 1903. Serial No. 166,484. (No specimens.)

To all whom it may concern:

Be it known that I, COSMO KENDALL, a subject of the King of Great Britain and Ireland, residing at Upper Norwood, in the county of Surrey, England, have invented Improvements in the Separation of Mineral Substances by Means of the Selective Action of Oil, of which the following is a specification.

According to this invention crushed graphite-containing material—for example, graphite ore or graphite waste—is mixed with water and brought intimately into contact or thoroughly mixed with pure thin oil—as, for example, kerosene or paraffin oil—which adheres to and by reason of its levity separates the graphitic substance (this may be more or less pure graphite) from associated rocky matter, which by reason of its weight and nonaffinity to oil sinks in and is conveniently carried off by the water. The graphitic substance is or may be afterward separated from the oil and the latter is or may be used again in subsequent similar operations. In separating graphitic substances in this way I do so or may do so by means of apparatus and in the manner that I will now describe. The crushed graphite-containing material mixed with water and oil is supplied to an agitator or mixer adapted to produce a thorough mixing of the materials under the action of gravity alone, and from this agitator or mixer the mixture passes in the form of a thin sheet or thin sheets or the like (preferably annularly and horizontally) and at a considerable velocity into a vessel, which is initially filled with water or water and oil and is of such a shape and has the material discharged into it in such a position as to enable water and rocky matter or gangue to pass off at an outlet or outlets at or near the bottom and the oil to carry the graphitic substance up with it to the surface, whence the mixture flows off to have the graphitic substance separated from foreign matter, including it may be the oil, in any suitable manner.

In one example of the treatment of graphite-containing material according to this invention the apparatus is employed that is shown diagrammatically in the accompanying drawings, whereof—

Figure 1 is a diagrammatical general sectional elevation of the apparatus, and Figs. 2 to 13, inclusive, are plans of twelve disks used therein.

The crushed material mixed with water and oil is supplied to an agitator or mixer comprising a number of disks or other plates *a*, perforated or made foraminous and horizontally disposed, spaced apart, and fixed within a vertical casing *b*. Below the agitator or mixer there is a vat *c*, containing water, into which the mixture is projected in a thin horizontal annular sheet *d* from a vertical pipe *e*, the lower end of which is, say, twenty-four inches below the top of the vat and is provided with a valve-like device *f*, by means of which at the bottom of the pipe *e* an annular outlet of, say, twenty-four inches in diameter is formed and which can be adjusted in depth by means of a hand-wheel *m* to vary the cross-sectional area of the outlet. The oil and the graphitic substance carried by it rise to the surface of the water in the vat and flow over the rim of the vat into an inclined launder *g*, from which they flow into a settling-tank *h*, (or series of settling-tanks or into a vessel similar to that above described.) From the settling tank or tanks the surface matter flows into a closed receptacle *i*, whence it can be forced by means of compressed air through a pipe *j* into a filter-press *k*. The plates *a* of the agitator or mixer have their perforations so arranged and shaped that different portions of the materials will be caused to flow at different rates within the agitator or mixer, and will consequently become thoroughly mixed.

Figs. 2 to 13, inclusive, are plans of the twelve disks employed in the apparatus shown and show relative sizes and an arrangement of the perforations *l* thereof by means of which the effect desired can be attained. The total area of the perforations *l* in each disk *a* is equal to the cross-sectional area of the narrowest portion of the pipe plus an amount necessary to compensate for friction. The vat *c* is so shaped that inclined surfaces *n* and *o* deflect

the ascending oily matter into a constricted annulus p of, say, a diameter of forty-eight inches and a width of an inch and a half, and another inclined surface r deflects the falling water and rocky matter or gangue toward an outlet s, which is centrally arranged and is, say, forty-eight inches below the bottom of the pipe e. The oil may be mingled with the material to be treated as it is borne to the top of the agitator or mixer through a channel t by a sufficiency of water supplied to it in a conduit u, as through perforations in a pipe v, the oil passing into the mixture through a number of fine orifices arranged to discharge beneath the moving mass of material. The oil may thus be supplied by a number of pipes x, which are at right angles to the direction of flow of the material and have perforations to discharge the oil in the same direction as that of the material and each of which has behind it an inclined plane y, adapted to direct the material to be treated slightly upward and over the perforations of the corresponding oil-pipe x. The rocky matter or gangue issuing from the vat may be passed to another and similar agitator or mixer for like treatment if necessary. The remaining oil in the cakes of the filter-press may be partly or wholly displaced by a subsequent water wash, and thereby partly or wholly recovered.

It will be understood that the dimensions hereinbefore stated may be varied in accordance with the quantity of material to be treated in a given time, and they are given only by way of example, having been found suitable in practice.

What I claim is—

1. The hereinbefore-described process for the treatment of finely-divided material for the separation of graphitic substance contained therein from associated rocky matter or gangue, consisting in mixing said material with water, bringing said material intimately into contact or thoroughly mixing it with suitable pure thin oil, as kerosene or paraffin oil, projecting at a considerable velocity the mixture so produced under the surface of a volume composed of said material, water, and oil, allowing oil and graphitic substance adhering thereto to pass upward to said surface, and drawing off from said surface oil and graphitic substance immediately on arrival at said surface.

2. The hereinbefore-described process for the treatment of finely-divided material for the separation of graphitic substance contained therein from associated rocky matter or gangue, consisting in mixing said material with water, bringing said material intimately into contact or thoroughly mixing it with suitable pure thin oil, as kerosene or paraffin oil, projecting horizontally or substantially horizontally the mixture so produced under the surface of a volume composed of said material, water, and oil, allowing oil and graphitic substance adhering thereto to pass upward to said surface, and drawing off from said surface oil and graphitic substance immediately on arrival at said surface.

3. The hereinbefore-described process for the treatment of finely-divided material for the separation of graphitic substance contained therein from associated rocky matter or gangue, consisting in mixing said material with water, bringing said material intimately into contact or thoroughly mixing it with suitable pure thin oil, as kerosene or paraffin oil, projecting at a considerable velocity the mixture so produced under the surface of a volume composed of said material, water, and oil, allowing oil and graphitic substance adhering thereto to pass upward to said surface, drawing off from said surface oil and graphitic substance immediately on arrival at said surface, and forcing matter so drawn off into a filter-press so as to recover oil.

4. The hereinbefore-described process for the treatment of finely-divided material for the separation of graphitic substance contained therein from associated rocky matter or gangue, consisting in mixing said material with water, bringing said material intimately into contact or thoroughly mixing it with suitable pure thin oil, as kerosene or paraffin oil, projecting horizontally or substantially horizontally the mixture so produced under the surface of a volume composed of said material, water, and oil, allowing oil and graphitic substance adhering thereto to pass upward to said surface, drawing off from said surface oil and graphitic substance immediately on arrival at said surface, and forcing matter so drawn off into a filter-press so as to recover oil.

5. The hereinbefore-described process for the treatment of finely-divided material for the separation of graphitic substance contained therein from associated rocky matter or gangue, consisting in mixing said material with water, bringing said material intimately into contact or thoroughly mixing it with suitable pure thin oil as kereosene or paraffin oil, projecting in the form of a thin sheet and at a considerable velocity the mixture so produced under the surface of a volume composed of said material, water, and oil, allowing oil and graphitic substance adhering thereto to pass upward to said surface, and drawing off from said surface oil and graphitic substance immediately on arrival at said surface.

6. The hereinbefore-described process for the treatment of finely-divided material for the separation of graphitic substance contained therein from associated rocky matter or gangue, consisting in mixing said material with water, bringing said material intimately into contact or thoroughly mixing it with suitable

pure thin oil, as kerosene or paraffin oil, projecting horizontally or substantially horizontally in the form of a thin sheet and at a considderable velocity the mixture so produced under the surface of a volume composed of said material, water, and oil, allowing oil and graphitic substance adhering thereto to pass upward to said surface, and drawing off from said surface oil and graphitic substance immediately on arrival at said surface.

Signed at London, England, this 10th day of July, 1903.

COSMO KENDALL.

Witnesses:

H. D. JAMESON,

A. NUTTING.

No. 776,145. PATENTED NOV. 29, 1904.

C. V. POTTER.

PROCESS OF SEPARATING METALS FROM SULFID ORES.

APPLICATION FILED JAN. 14, 1902.

NO MODEL.

Fig. 1

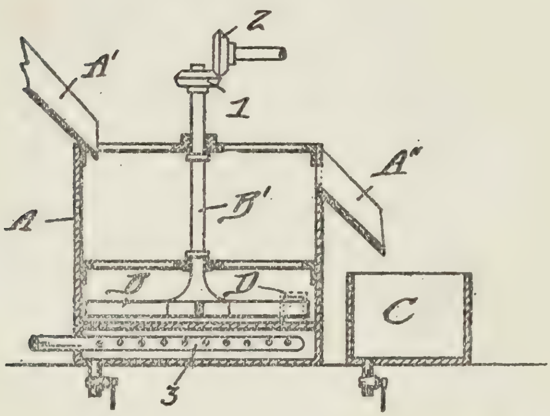
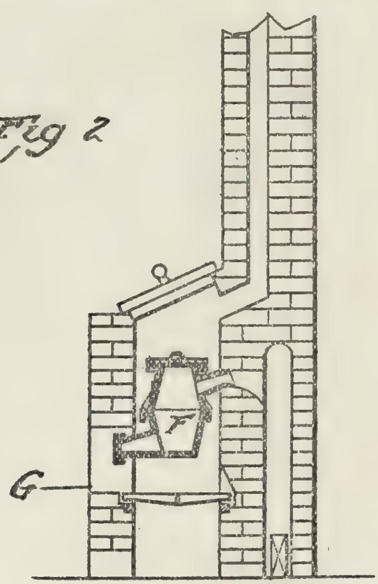


Fig 2



Attest:
C. S. Middleton
S. B. Middleton

Inventor
Charles V. Potter
By Richards & Co.
Attys

No. 776,145. Patented November 29, 1904.

UNITED STATES PATENT OFFICE.

CHARLES VINCENT POTTER, OF BALACLAVA, VICTORIA, AUSTRALIA.

PROCESS OF SEPARATING METALS FROM SULFID ORES.

SPECIFICATION forming part of Letters Patent No. 776,145, dated November 29, 1904

Application filed January 14, 1902. Serial No. 89,772. (No specimens.)

To all whom it may concern:

Be it known that I, CHARLES VINCENT POTTER, engineer, a British subject, and a resident of 43 The Avenue, Balaclava, in the State of Victoria, Commonwealth of Australia, have invented an Improved Process of Separating Metals from Sulfid Ores, of which the following is a specification.

The object of my invention is to separate metals from sulfid ores by an expeditious, effective, and inexpensive means and method.

The crude ore, concentrates, tailings, or slimes after being pulverized are placed in a suitable vat or vessel and a solution is then added, such solution consisting of water with the addition of from one per cent. to ten per cent. of any acid, (preferably sulfuric acid, for reasons hereinafter stated,) the acidulated strength of the solution being determined by the quality or nature of the sulfid ore to be treated. The small quantity of acid added does not act as a solvent.

Ores containing lead, zinc, copper, iron, gold, and silver in combination with sulfur I treat as follows: The ore in a state of fine division is placed in a vat or such like vessel provided with an internal stirrer or stirrers. The acidulated solution is then added thereto, such solution containing in the first instance, say, one per cent. only of the acid when mixing it with the ores, and after heat is applied thereto, as hereinafter directed, gradually increasing its acidulated strength until the determinate strength is reached, which in most instances will amount to two and a half per cent. of acid, or thereabout, to be decided on or governed by the apparent action of the solution on the material under treatment. Heat being applied, the effect of the acidulated solution becomes apparent by the bubbling up and gathering on the surface of the fluid of the metallic concentrates in the form of a pasty mass. Should this pasty substance be scanty, thin, and not swell and accumulate rapidly, so as to overflow the vat if not skimmed off, more acid must be added until the maximum separative activity is reached, which very slight experience and observation in applying this treatment to sulfid ores will enable the operator to determine. I use sulfuric acid preferably by reason of its cheapness and its capability of production from a by-product resulting from the process or treatment herein described. While the exact acidulated strength of such solution will depend on the metallic contents and general condition of the ore, ascertainable only by observation when under treatment as aforesaid, any variation of the acidulated strength found necessary or expedient will remain well within the limit before stated—namely, of from one to ten per cent. of the whole solution. The bulk solution to be added or applied to the class of ores lastly named would be, say, approximately two hundred and fifty gallons to every ton weight of ore, varying to some small extent, according to the absorbent quality of the ore and its degree of fineness. The stirrers are then freely used, and heat is applied to the vat or vessel directly or by means of steam injection therein at or near the floor of the vat or vessel. As the temperature of the solution and other contents of the vat or vessel rises it causes the metals to rise upward from the bottom of the vat and float upon the surface, from which it may be allowed to flow automatically and continuously into a separate receptacle or be skimmed off, as arranged, into a separate vessel for further treatment. The gangue accumulating in the bottom of the separating-vat, containing a small proportion of gold and silver, as well as all the rhodonite, garnets, silica, and the like, can be then further treated by cyanid or other of the well-known means or processes and the gold and silver be thus extracted therefrom. The said solution may be used over and over again by the addition from time to time of a small quantity of acid when it is apparent by the effect of the solution when reapplied to the material and heated that its acidulated strength has become diminished. The skimmings or concentrates, containing all the metals free from gangue, are then mixed with a certain quantity of crushed or coarsely broken-up iron or iron oxid, (the quantity of such iron required depending upon the quantity of sulfur the metals

contain,) also a quantity of powdered charcoal. This mixture is then placed in a suitable vessel or retort and a rapidly-produced heat applied, converting the mixture into a molten condition. After a short period it will be found that the sulfid of lead and silver has been reduced to metallic lead and silver. The retort can then be tapped at the bottom and these metals run off. In this step the iron changes places with the lead of the galena, the equation being Pbs+Fe=Fe.S+Pb. It will thus take fifty-six pounds of cast-iron to reduce two hundred and thirty-nine pounds of galena to two hundred and seven pounds of metallic lead. While this reduction is taking place the iron, having changed places with the lead, becomes sulfid of iron, and the zinc by the action of the great heat is vaporized and passed off in the form of vapor into a suitable vessel, wherein it becomes condensed into metallic zinc. The iron sulfid remaining in the retort is recrushed and roasted, the sulfur resulting from which may be utilized for the manufacture of sulfuric acid.

The means or process for treating ores, chiefly for the recovery of the gold therein, in combination with sulfur, such as iron pyrites or arsenical pyrites, is as follows: The ore is ground to a very fine powder, (the finer the better,) placed in a vat or suitable vessel, the said solution added, well stirred, and the heat applied in exactly the same manner as before described in relation to the lead and silver ores, thus separating the gold and other metals from the gangue in manner as before described. The skimmings or concentrates, which are now in a very small bulk containing practically all the gold, are then roasted in a suitable furnace, after which they will be in a condition to be treated by chlorin or cyanid in the well-known manner. By this treatment the difficulties of treating a large bulk of ores mixed with slimes and the necessity for dealing with the slimes by filtration are obviated and dispensed with and a better and more complete result obtained.

The accompanying drawings show, for example, a series of receptacles for carrying out the above-described process, in which—

Figure 1 is a sectional elevation of a vat and the tank; and Fig. 2 is a like view of the retort with its furnace.

In the drawings, A is the vat, having the chute A′ leading thereto, and B indicates the stirrer-arms, secured to a shaft B′, the stirrer-arms being rotated by means of the gearing 1 2 from a suitable source of power. The vat is shown as being heated by a gas-pipe 3, placed below the bottom of the vat. D is a door in the vat.

C indicates the separate tank, and A″ the chute for allowing the skimmings to flow from vat A to said tank C.

Fig. 2 shows the retort F placed in the furnace G, so as to be heated thereby.

Having now described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. The herein-described process of separating metals from pulverized sulfid ores which consists in adding to the same an acid solution which is a non-solvent of the precious metals, then applying heat to the same, and removing the sulfids from the surface of the solution, substantially as described.

2. The process of separating metals from pulverized sulfid ores, concentrates, and slimes by mixing an acidulated solution therewith which is a non-solvent of the metal to be separated, stirring, heating, skimming or floating off such metals from the surface of the whole admixture as they are carried to the surface so as to recover such concentrates of metals ready for after treatment, as, and in manner hereinbefore described.

3. The method of separating sulfid ores from their gangue, which consists in forming a suitable solution containing sulfuric acid to react on the soluble sulfids present to form bubbles of sulfureted hydrogen on the ore particles and thereby raise them to the surface, and removing the ore particles so raised, substantially as described.

In witness whereof I have hereunto set my hand in presence of two witnesses.

CHARLES VINCENT POTTER.

Witnesses:
ALFRED FORD,
JONATHAN BEAR.

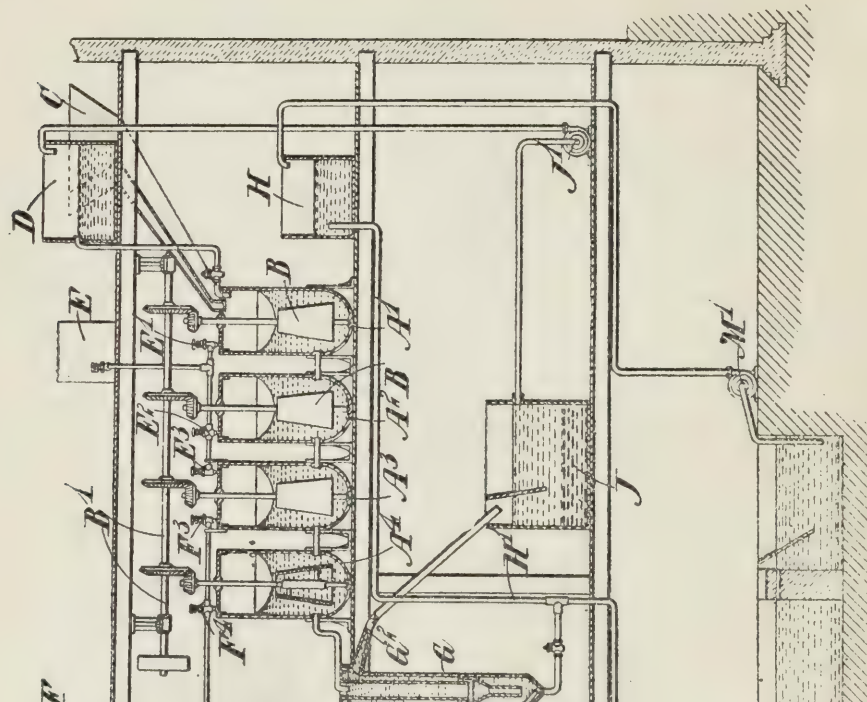
No. 777,273. PATENTED DEC 13, 1904.

A. E. CATTERMOLE

SEPARATION OF THE METALLIC CONSTITUENTS OF ORES FROM GANGUE.

APPLICATION FILED SEPT 28, 1903

NO MODEL.



Witnesses.
Harold Elwood
Mabel Hayes

Inventor
Arthur E. Cattermole
By Knight Bros.
Attorneys

No. 777,273. Patented December 13, 1904.

UNITED STATES PATENT OFFICE.

ARTHUR EDWARD CATTERMOLE, OF LONDON, ENGLAND.

SEPARATION OF THE METALLIC CONSTITUENTS OF ORES FROM GANGUE.

SPECIFICATION forming part of Letters Patent No. 777,273, dated December 13, 1904.

Application filed September 28, 1903. Serial No. 174,947. (No specimens.)

To all whom it may concern:

Be it known that I, ARTHUR EDWARD CATTERMOLE, a subject of the King of England, residing at Highgate, London, England, have invented certain new and useful Improvements in the Separation of the Metallic Constituents of Ores from Gangue, of which the following is a specification.

The present invention relates to improvements in the separation of the metalliferous constituents of ores and the like from gangue by means of the selective action of oils and certain tar products or similar compounds (all hereinafter referred to as "oil") on metallic or metalliferous matter.

The invention depends upon the application of the following facts: First, when a mixture of powered metalliferous matter and gangue is treated with oil suspended in water—that is to say, in emulsion—the oil has a more or less selective action and will coat the particles of metalliferous matter in preference to the particles of gangue, while the particles of gangue will be wetted by the water; second, if the water which is mixed with the oil is acidulated with mineral, fatty, or other acid the selective action of the oil will thereby be rendered more marked and decisive; third, if the proportion of oil is kept within reasonably low limits (differing in different cases, according to the nature of the mineral to be treated and the consistency and nature of the oil) and if the mixture of water, oil, metalliferous particles, and gangue be thoroughly agitated the metalliferous particles which have become coated with oil will adhere together and form granules, which granules, partly by reason of gravity or partly on account of their bulk, as compared with the individual grains of gangue, will offer ready means for separation in an up-current separator, a jig, or other similar appliance. This action is facilitated if the oil before addition to the liquor is brought into the condition of an emulsion in water containing a small percentage of soap or other emulsifying agent. These facts are utilized for the purpose of separating the metalliferous constituents from the gangue of the ore in the following manner: In a suitable apparatus, an example of which will be hereinafter described, the ground or pulped ore is caused to be violently agitated, as by a revolving stirrer, in a mixture of water and oil, the liquor being acid. As the agitation proceeds the particles of metalliferous matter agglomerate together and may be observed in the form of granules, the size of which will depend, among other things, upon the percentage of oil used. This granulation of the metalliferous constituents of the ore affords the means by which at a later stage of the process it is possible to separate the metalliferous material from the gangue, as will be hereinafter particularly described. In practice a continuous process is used—that is to say, water, ground ore, or pulp and oil, preferably emulsified, are continuously fed into a series of vessels, and the products of the agitation are continuously fed into an up-current separator or jig or similar device, which in the case of the up-current separator separates the metalliferous granules from the gangue by allowing them to fall to the bottom of the vessel and to be carried away by a downward stream, while the particles of gangue are carried away by an upward steam.

The accompanying drawing is a diagram illustrating in sectional view one means of carrying out the process according to this invention, in which the liquid mass is brought into an acid condition.

A series of connected mixing vessels $A' A^2 A^3 A^4 A^5 A^6$ are provided with stirrers B, rotated from driving-shafts B'. Crushed ore from a hopper C and water from a tank D are introduced into the first vessel, A', and oil or emulsion is fed from a tank E, through pipes $F' F^2 F^3$, to the various vessels. The mixture is vigorously agitated to break up and emulsify the oil and to bring about intimate contact of the divided oil with the metalliferous mineral particles and of the oiled particles with each other. It is found under these conditions the metalliferous mineral particles abstract the oil and become coated with a thin oily film, which is insufficient to materially lessen their specific gravity, and that under agitation such slightly-oiled particles adhere, nucleate, and agglomerate into small more or less rounded masses or granules disseminated

throughout the mass of gangue, which remains free and practically devoid of oil. In order to maintain the liquid mass in which the separation is effected in an acid condition, a small proportion of the sulfuric or other acid is introduced into one or more of the vessels from a tank F, having discharge-pipes F^3 F^4 F^5 F^6. After agitation to a certain extent (in four vessels, as illustrated, for example) the mixture is passed into an up-current classifier G, which is supplied with a stream of acidulated water from a tank H through a pipe H'. As the granules remain specifically heavier than the gangue or can by suitably adjusting the amount or oil and the agitation be obtained of a size larger than that of the gangue particles, the granules, with a certain amount of heavy sands, sink to the bottom and are discharged through a pipe G' into the vessel A^6, while the lighter sands are carried away by the upward current and discharged through outlet G^2 to a light-sands tank J, from which the water may be returned by a pump J' to the feed-tank D for reuse. In order to separate the granules from the heavy sands, the mixture is subjected to further agitation in the vessels A^5 A^6 and is then passed into a second classifier K, from which the granules are removed at the bottom by the pipe K' into the metalliferous-mineral tank L, while the heavy sands are discharged from the upper pipe K^2 into a heavy-sands tank M. The water from the tanks L and M is returned by a pump N' to the feed-water tank H. This apparatus is illustrated only as one convenient method of carrying out this invention, and it is to be understood that its nature and arrangement can be considerably varied. Thus the acid condition may be obtained by acidulating the ore-pulp before agitation with the oil or oil emulsion, or the ore-pulp may be first agitated with emulsion to slightly agglomerate the ore, which may be settled and washed and the product then treated by agitation with acid solution to granulate the mineral and free the gangue. Which of the methods is most applicable depends upon the nature of the mineral matter and of the gangue, their state of division, and relative proportions. The agitation vessels may be separate, with arrangements for charging and discharging, the charging with pulp and the addition of acid and of oil or emulsified oil and the agitation and discharge successively in the series of vessels being so timed that the output of treated ore is kept continuous and constant. The classifiers used may be jigs, shaking-tables or the like, or sizing apparatus, whereby the comparatively larger mineral granules may be separated from the finer gangue and one or more classifiers may be employed.

The proportion of oil used depends upon its viscosity, the fineness of the ore and other factors, and the consistency and size of the mineral granules desired. The more oil used the larger, softer, and less numerous the granules. With, say, ten per cent. of oil to the weight of metalliferous mineral a few pasty masses of oil-agglomerated metalliferous mineral matter will generally result. Oil in excess of this may cause all the granules to coalese into one soft mass. Usually an amount of oil varying from four per cent. to six per cent. of the weight of metalliferous mineral matter present in the ore yields granules of suitable size, consistency, and specific gravity for ready separation from the gangue in the up-current or other apparatus used for classification.

The amount of emulsifying agent if used to form the oil emulsion depends upon the viscosity and nature of the oil. When soap is employed, an amount varying from three per cent. to five per cent. of the weight of oil usually suffices, this being dissolved in, say, ten times its weight of water. For emulsification a low alkalinity of the emulsifying agent is generally best.

The "oil" used may be animal, vegetable, or mineral oil or mixtures of these or such coal or wood tar products or other substances which exercise, like oils, a preferential physical affinity for metallic mineral matter as distinguished from gangue. The emulsifying agent (if such is used) may be any substance capable of holding the oil in a fine state of division in suspension in water without acting on the mineral matter or preventing the action of the oil—for example, soap, alkaline cresylates, or other substances, solutions of which in water froth on agitation. The emulsifying agent, or the constituents liberated therefrom under the action of acid, appears to have a decided effect in aiding the granulation, as described. In some cases, as with wood-tar and some coal-tar products, these when agitated in weak alkaline solutions provide their own emulsifying agents, soluble resinates, cresylates, &c., being thereby formed which emulsify the bulk of the tar or product. In this process the amount of emulsifying agent employed is kept as low as possible compatible with the proper subdivision of the oil to prevent undue waste of the alkaline or basic constituent present, which is necessarily destroyed in the acid solution used. When soap is used, the fatty acid becomes associated with the mineral granules and can be subsequently recovered. Emulsification in some cases, as with the heavier residuum oils or tars, may be assisted by first mixing therewith a small amount of fatty oil or fatty acid. Preferably one emulsifying agent is employed throughout the process.

In order to recover the oil from the granules after their separation from the gangue, they may be agitated with the emulsifying agent in a stronger or more active condition or proportion than was used in the emulsification of the oils initially, and the action of this

emulsifying agent in stripping the oil from the metalliferous mineral particles may be aided by attrition. The strengthening of the emulsifying agent may be effected by increasing the proportion of the agent or of the alkaline base in solution, or both, the percentage strength of the solution needed depending upon the oil used and the nature of the metalliferous mineral matter with which it is associated. Usually if oleic soap is employed and caustic potash amounts varying from one-quarter of one per cent. to three per cent. or four per cent. of one or the other in solution suffice, the less readily emulsified oils, as the residuum oils, requiring the larger amounts. The removed oil is obtained as a dilute emulsion, which on standing some time separates. The cream or concentrated emulsion may then be used for making fresh emulsion for treating fresh ore. To hasten this separation of "cream," mechanical devices may be employed.

Generally with wet crushed ore removal of the bulk of the water for reuse in the mill is necessary. In such case the pulp is settled and the wet ore only fed into the agitators, acid-water being added to thin them. The circuit of such liquids can thus be kept distinct from that of the mill-water, suitable arrangements being made for settling the mineral-depleted sands and slime and for addition of acid and fresh water, as required from time to time.

In certain cases, as where but little mineral is present in the ore, to increase the nucleating or granulating factor pulverized mineral matter obtained in a previous operation or other matter having an affinity for oil from a different source may be introduced into the ore, or a portion of already granulated and separated mineral matter may be returned to maintain the necessary amount of mineral in the ore under treatment.

In carrying out the process the ore may be roughly sized into two or more parts, which are then treated separately. With certain ores it may be preferable to use in some stages of the process a rolling form of agitation, as in cylinders or barrels, to obtain good granulation of the mineral.

It has been found that if the water in which the operation is conducted contains a percentage of acid, varying in the case of sulfuric acid of 1.84 specific gravity from one-half of one per cent. to a tenth of one per cent., the operation is greatly facilitated. Indeed, if there is no acid present there is a great tendency for the oil to coat the gangue or some portion of the gangue, as well as the metalliferous particles. It is preferable to use water acidulated with about one-fifth of one per cent. of this acid, and it is found in practice that such a degree of acidulation is sufficient completely to prevent the gangue from being oiled, while it is not, generally speaking, enough to cause the water to act chemically upon the metalliferous matter.

I am aware that the selective action of oils and the like on metallic matter has been made the basis of previous processes for separating the metalliferous constituents of ores from gangue. For example, oil has been used to float off metalliferous mineral from ore-pulp, and its use has also been proposed to form a pasty mass of crushed ore from which the gangue could afterward be washed out by means of water, and I do not claim the employment of oil in any such manner.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. The herein-described process of separating metalliferous matter from gangue which consists in mixing the pulp with an amount of oil equaling only a fraction of the metalliferous constituents, agitating the mass until the oil-coated metalliferous matter is agglomerated into granules and subjecting the mixture to classification to remove the small non-coated particles from the granules.

2. The herein-described process of separating metalliferous matter from gangue which consists in mixing the ore with an emulsion containing an amount of oil equaling only a fraction of the metalliferous constituents agitating the mass until the oil-coated metalliferous matter is agglomerated into granules and subjecting the mixture to classification to remove the small non-coated particles from the granules.

3. The herein-described process of separating metalliferous matter from gangue which consists in mixing the ore with an emulsion containing an amount of oil equaling only a fraction of the metalliferous constituents and an acid, agitating the mass until the oil-coated metalliferous matter is agglomerated into granules and subjecting the mixture to classification to remove the small non-coated particles from the granules.

4. The herein-described process of separating metalliferous matter from gangue which consists in mixing the ore with an emulsion containing an amount of oil equaling only a fraction of the metalliferous constituents and an acid, agitating the mass until the oil-coated metalliferous matter is agglomerated into granules and subjecting the mixture to up-current classification to remove the small non-coated particles from the granules.

5. The herein-described process of separating metalliferous matter from gangue which consists in mixing the ore with an emulsion containing an amount of oil equaling only a fraction of the metalliferous constituents and an acid, agitating the mass until the oil-coated metalliferous matter is agglomerated into granules and separating out the light sands, thereafter further agitating the mass to increase the size of the granules and separating out the heavy sands from the granules

6. The herein-described process of separating metalliferous matter from gangue which consists in agitating a mixture of powdered ore, oil emulsion and water containing an acid and adding particles of material having an affinity for oil to assist in the formation of granules of oil-coated particles and subjecting the mixture to a classification to remove the small non-coated particles from the granules.

7. The herein-described process of separating metalliferous matter from gangue which consists in agitating a mixture of powdered ore, oil emulsion and water containing an acid and adding particles of material having an affinity for oil to assist in the formation of granules of oil-coated particles and subjecting the mixture to classification to remove the small non-coated particles from the granules.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses

ARTHUR EDWARD CATTERMOLE.

Witnesses:
HAROLD WADE,
HARRY B. BRIDGE.

No. 777,274. Patented December 13, 1904.

UNITED STATES PATENT OFFICE.

ARTHUR EDWARD CATTERMOLE, HENRY LIVINGSTONE SULMAN, AND HUGH FITZALIS KIRKPATRICK-PICARD, OF LONDON, ENGLAND.

CONCENTRATION OF MINERALS FROM ORES.

SPECIFICATION forming part of Letters Patent No. 777,274, dated December 13, 1904.

Application filed March 29, 1904. Serial No. 200,650. (No specimens.)

To all whom it may concern:

Be it known that we, ARTHUR EDWARD CATTERMOLE, HENRY LIVINGSTONE SULMAN, and HUGH FITZALIS KIRKPATRICK-PICARD, subjects of the King of England, residing at London, England, have invented certain new and useful Improvements in the Concentration of Minerals from Ores, of which the following is a specification.

Our process has for its object the separation of minerals from the silicious or earthy matters of ores by means of soaps or similar compounds, and is dependent upon the superior physical attraction exhibited by minerals for fatty or resin acids or for certain other aromatic derivatives (such as cresols, phenols, &c.) which form soluble salts or compounds with alkaline hydrates as compared with earthy or silicious substances.

The process described in this application relates to a process somewhat similar to the process described and claimed in a copending application filed by us of even date with this application and serially numbered 200,649.

In general the soluble compounds we employ are typified by ordinary soaps, from which the fatty or resin acids are liberated by the addition of a suitable mineral acid and which fatty or resin acids are again rendered completely soluble by the addition of an equivalent of caustic alkali.

In carrying out our invention the suitably-crushed ore is suspended in water, and to the mixture an addition of a small quantity of soap solution is made. A small amount of mineral acid is then added, which decomposes the soluble soap or other similar compound by uniting with the alkaline base thereof, thus liberating in a state of chemical subdivision the fatty or resin acid or other compound, such as cresol, &c., in intimate contact with the suspended ore particles. It is found that the liberated acids, &c., which may even be solid under ordinary conditions, are precipitated and adhere to the sulfureted minerals or to sulfur, graphite, or free metals present in the ore, leaving the gangue or earthy particles preferentially wet by water and free from adhesions of fatty acid and the like. The fatty acid and the like used for the purpose of adhering to the mineral particles is thus produced *in situ* throughout the suspended ore mass in the most intimate contact or admixture therewith, and the mineral particles become attached to or more or less coated by films of fatty or resin acid. The mixture containing water, fatty or resin acid, metalliferous particles, and gangue is now thoroughly agitated, and the coated metalliferous particles adhere together and form granules or small agglomerate masses, which partly by reason of gravity and partly on account of their bulk, as compared with the individual grains of gangue, may be readily separated in upcurrents or by other suitable classification apparatus. This process may conveniently be rendered continuous by feeding ore-pulp, soap solution, and mineral acid continuously into one or more agitating vessels and discharging the products of agitation into an up-current separator, which allows the metalliferous granules to fall to the bottom of the vessel, while the particles of gangue are carried away by an upward stream.

The apparatus employed may be of the type described in Cattermole's United States Patent No. 763,260.

After separation of the coated mineral particles the recovered mineral concentrate is subjected to the action of a suitable amount of caustic or carbonated alkali, whereby the fatty or resin acid, &c., recombines completely with the alkali, forming a readily-soluble soap or alkaline compound. After draining this off and washing with water, if necessary, the mineral particles are left clean and free from soap. The resulting solution thus contains all the soap or equivalent compound originally used in a state ready for immediate employment in the separation of mineral from fresh quantities of ore, and the process becomes completely cyclic with regard to the soap employed.

Throughout the operation the same soap or similar compound is used, the constituent whereof may be quite solid under ordinary conditions, the only additions required being

small quantities of mineral acid and alkali for the decomposition and recomposition of this agent during the cycle of operations.

What we claim as our invention, and desire to secure by Letters Patent, is—

1. The herein-described process of concentrating ores which consists in mixing the ore-pulp with a soap solution and a mineral acid so as to liberate from the soap the organic acid which coats the desired mineral particles but not the gangue, agitating the mixture so as to agglomerate the coated mineral particles into granules and separating the granules from the non-coated gangue.

2. The herein-described process of concentrating ores which consists in mixing the ore-pulp with a soap solution and a mineral acid which liberates the organic acid from the soap, agitating the mixture so as to agglomerate the coated mineral particles into granules, separating the granules from the non-coated gangue and adding alkali to the granules to reproduce the soluble soap.

In testimony whereof we have signed our names to this specification in the presence of two subscribing witnesses.

ARTHUR EDWARD CATTERMOLE.
HENRY LIVINGSTONE SULMAN.
HUGH FITZALIS KIRKPATRICK-PICARD.

Witnesses:
FREDERICK READ,
F. B. BYSS.

No. 788,247. Patented April 25, 1905.

UNITED STATES PATENT OFFICE.

ARTHUR EDWARD CATTERMOLE, HENRY LIVINGSTONE SULMAN, AND HUGH FITZALIS KIRKPATRICK-PICARD, OF LONDON, ENGLAND.

ORE CONCENTRATION.

SPECIFICATION forming part of Letters Patent No. 788,247, dated April 25, 1905.

Application filed March 29, 1904. Serial No. 200,649.

To all whom it may concern:

Be it known that we, ARTHUR EDWARD CATTERMOLE, HENRY LIVINGSTONE SULMAN, and HUGH FITZALIS KIRKPATRICK-PICARD, subjects of the King of England, residing at London, England, have invented certain new and useful Improvements in Ore Concentration, of which the following is a specification.

Our process has for its object the separation of minerals from the silicious or earthy matters of ores by means of soaps or similar compounds, and is dependent upon the superior physical attraction exhibited by minerals for fatty or resin acids or for certain other aromatic derivatives—such as cresols, phenols, &c.—which form soluble salts or compounds with alkaline hydrates, as compared with earthy or silicious substances.

The process described in this application relates to a process somewhat similar to the process described and claimed in a copending application filed by us of even date with this application and serially numbered 200,650.

In general the soluble compounds we employ are typified by ordinary soaps, from which the fatty or resin acids are liberated by the addition of a suitable mineral acid and which fatty or resin acids are again rendered completely soluble by the addition of an equivalent of caustic alkali.

In carrying out our invention the suitably-crushed ore is suspended in water, and to the mixture an addition of a small quantity of soap solution is made. A small amount of mineral acid is then added, which decomposes the soluble soap or other similar compound by uniting with the alkaline base thereof, thus liberating in a state of chemical subdivision the fatty or resin acid or other compound, such as cresol, &c., in intimate contact with the suspended ore particles. It is found that the liberated acids, &c., which may even be solid under ordinary conditions are precipitated and adhere to the sulfureted minerals or to sulfur, graphite, or free metals present in the ore, leaving the gangue or earthy particles preferentially wetted by water and free from adhesions of fatty acid and the like. The fatty acid and the like used for the purpose of adhering to the mineral particles is thus produced *in situ* throughout the suspended ore mass in the most intimate contact or admixture therewith. The mineral particles now attached to or more or less coated or inclosed by films of fatty or resin acids and the like are capable of being separated from the gangue or earthy particles by various methods dependent upon this altered physical condition. For example, the coated mineral particles may be removed by generating gaseous bubbles in the mixture which preferentially attach themselves to the fatty or similar acid-coated particles and raise them to the surface of the pulp, whence they may be removed by skimming or the like. If the ore contains a carbonate, any small excess of the acid used to decompose the soap or similar alkaline compound will also liberate bubbles of carbonic acid, which will attach themselves to the fatty acid-coated mineral particles and float them to the surface, or a suitable carbonate (or other substance capable of liberating a gas on the addition of a suitable acid, such as an easily decomposable sulfid, &c.) may be initially added to the ore mass for such purpose, or the mineral particles may be caused to adhere to metallic or other suitable surfaces coated with similar fatty acids, or, finally, the coated mineral particles may be caused to adhere to wood, sawdust, or other suitable material lighter than water coated with similar fatty acids, &c., which can then be removed by flotation, in each case leaving the mineral-free gangue particles capable of rejection. After separation of the coated mineral particles by any of the methods before mentioned the recovered mineral concentrate is subjected to the action of a suitable amount of caustic or carbonated alkali, whereby the fatty or resin acid, &c., recombines completely with the alkali, forming a readily soluble soap or alkaline compound. After draining this off, and washing with water, if necessary, the mineral particles are left clean and free from soap. The resulting solution thus contains all the soap or equivalent compound originally used

in a state ready for immediate employment in the separation of mineral from fresh quantities of ore, and the process becomes completely cyclic with regard to the soap employed.

Throughout the operation the same soap or similar compound is used, the constituent whereof may be quite solid under ordinary conditions, the only additions required being small quantities of mineral acid and alkali for the decomposition and recomposition of this agent during the cycle of operations.

What we claim as our invention, and desire to secure by Letters Patent, is—

1. The herein-described process of concentrating ores which consists in mixing a freely-flowing ore pulp with a soap solution and a mineral acid so as to liberate the organic acid from the soap throughout the suspended ore mass in intimate contact therewith, whereby the organic acid coats the desired mineral particles and not the gangue, and thereafter separating the coated mineral matter from the non-coated gangue.

2. The herein-described process of concentrating ores which consists in mixing the ore pulp with a soap solution and a mineral acid which liberates the organic acid from the soap, separating the coated mineral matter from the non-coated gangue and adding alkali to the coated mineral matter to reproduce the soluble soap.

3. The herein-described process of concentrating ores which consists in mixing a freely-flowing ore pulp with a soap solution and a mineral acid so as to liberate the organic acid from the soap throughout the suspended ore mass in intimate contact therewith, bringing the liquor into intimate contact with a gas which will adhere to the coated particles and separating out the coated mineral matter which floats.

4. The herein-described process of concentrating ores which consists in mixing the ore pulp with a soap solution and a mineral acid which liberates the organic acid from the soap, bringing the liquor into intimate contact with a gas, separating out the coated mineral matter which floats and adding thereto an alkali which reproduces the soluble soap.

In testimony whereof we have signed our names to this specification in the presence of two subscribing witnesses.

ARTHUR EDWARD CATTERMOLE.
HENRY LIVINGSTONE SULMAN.
HUGH FITZALIS KIRKPATRICK-PICARD.

Witnesses:
T. B. BUSS,
FREDERICK READ.

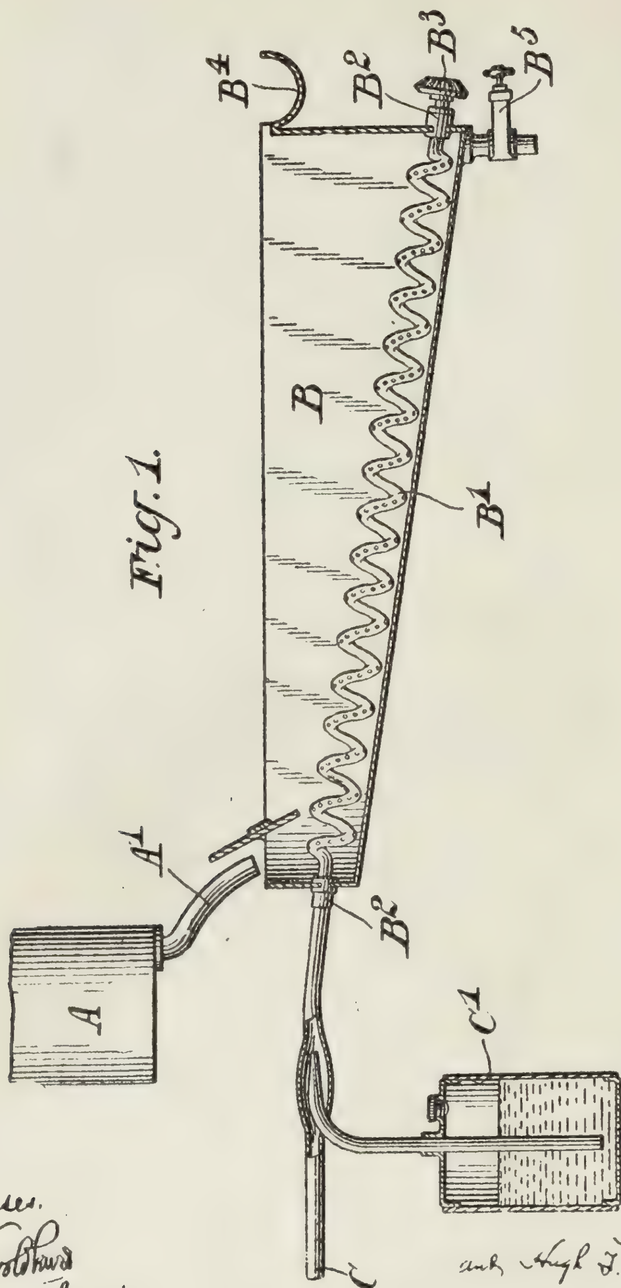
No. 793,808. PATENTED JULY 4, 1905.

H. L. SULMAN & H. F. KIRKPATRICK-PICARD.

ORE CONCENTRATION.

APPLICATION FILED OCT. 5, 1903.

3 SHEETS—SHEET 1.



Witnesses.
Harold Ward
J. M. Stigenkoop

Inventors
Henry L. Sulman
and Hugh F. Kirkpatrick-Picard
By Knight Bros
Attys.

No. 793,808. PATENTED JULY 4, 1905.

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ORE CONCENTRATION.

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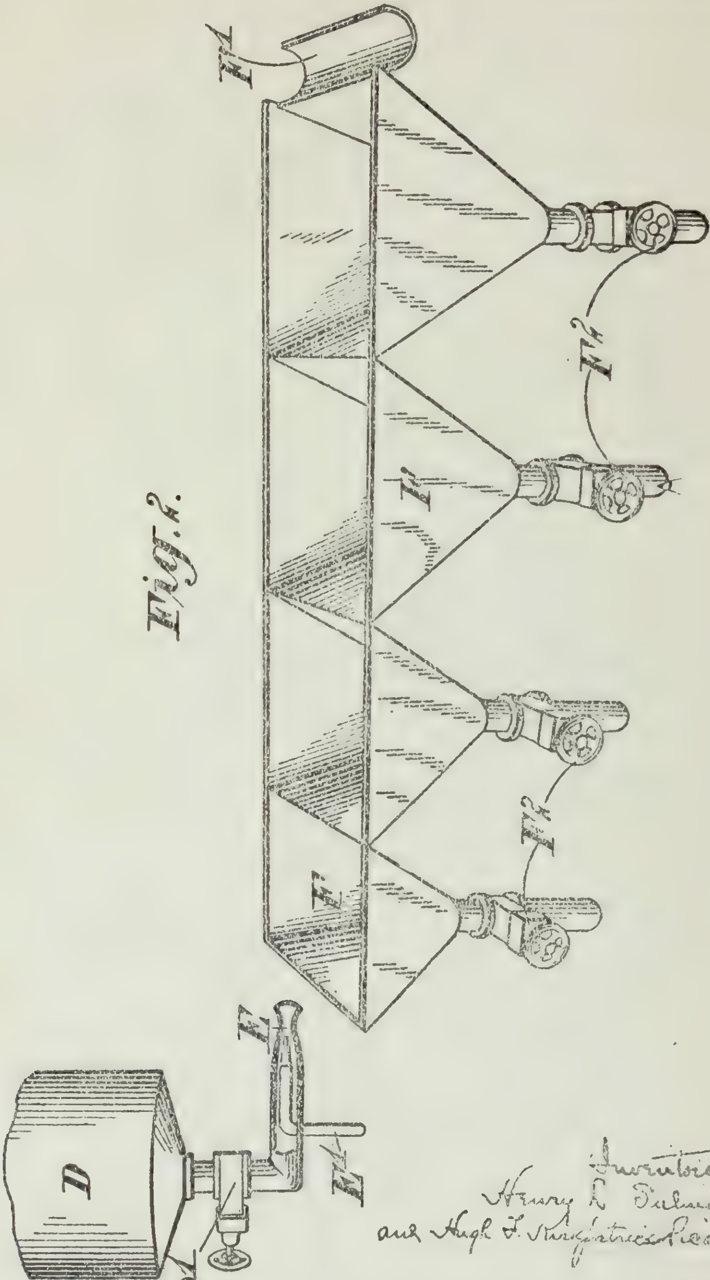

Fig. 2.

Witnesses:
Harold Kerr
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Inventors:
Henry L. Sulman
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Attys

No. 793,808. PATENTED JULY 4, 1905.

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ORE CONCENTRATION.

APPLICATION FILED OCT. 5, 1903.

3 SHEETS—SHEET 3.

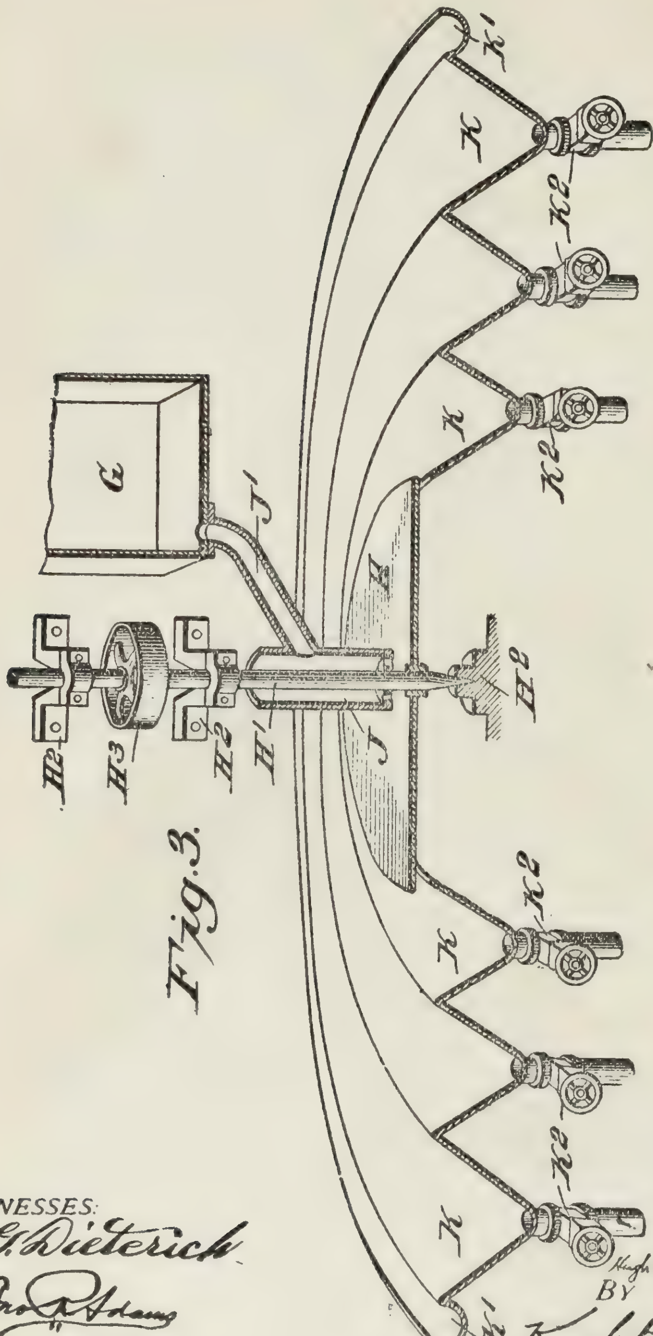


Fig. 3.

WITNESSES:
H. G. Dieterich
Jno. R. Adams

INVENTORS
Henry L. Sulman
Hugh Fitzalis Kirkpatrick Picard
BY
Knight Bros
Attorneys

No. 793,808. Patented July 4, 1905.

UNITED STATES PATENT OFFICE.

HENRY LIVINGSTONE SULMAN AND HUGH FITZALIS KIRKPATRICK-PICARD, OF LONDON, ENGLAND.

ORE CONCENTRATION.

SPECIFICATION forming part of Letters Patent No. 793,808, dated July 4, 1905.

Application filed October 5, 1903. Serial No. 175,871.

To all whom it may concern:

Be it known that we, HENRY LIVINGSTONE SULMAN and HUGH FITZALIS KIRKPATRICK-PICARD, subjects of the King of England, residing at London, England, have invented certain new and useful Improvements in or Relating to Ore Concentration, of which the following is a specification.

The present invention relates to the concentration of ores by separation of the metalliferous constituents and graphite, carbon, sulfur, and the like from the gangue by means of oils, grease, tar, or any similar substance which has a preferential affinity for metalliferous matter over gangue.

According to this invention we utilize the power which is possessed by films or bubbles of air or other gas of attaching themselves to solid particles moistened by oil or the like.

According to one method of carrying out our invention suitably-crushed ore is suspended in water. To this suspension a proportion of oil, grease, or tar (hereinafter referred to as "oil") is added and duly mixed with the mass by any suitable means in quantity insufficient to raise the oiled mineral by virtue of the flotation power of the oil alone. A suitable gas is now generated in or introduced into the mixture, such as air, carbonic-acid gas, sulfureted hydrogen, or the like. For example, bicarbonates or carbonates, either soluble or insoluble in water (preferably the latter) or easily-decomposable sulfids and the like may be used with acid solution. In such cases, if desired, the addition of acid may be made to the mixture after the addition of the gas-producing reagent. In the case of solutions containing free alkali the addition of acid sufficient to neutralize this must be made before the gas is produced. If desirable, gaseous bubbles may be produced by electrolytic methods or by means of various other known reactions.

According to another method of carrying out this invention the oil is not added alone; but the pulp is submitted to the action of a current of air or other gas bubbles, the air or other gas being first suitably charged either with the vapor of a volatile oil, such as petroleum of low boiling-point, or with the spray of any other suitable volatile or non-volatile or fixed oil or the like. The oil may be sprayed or reduced to a state of such fine division that minute globules of the same can remain temporarily suspended in an air or other gas current by the use of any suitable spraying or atomizing device and the air-current introduced into the ore-pulp, preferably at the bottom, by means of a pipe or pipes provided with suitable perforations or by other suitable contrivance. The minute oil globules or the condensed vapors or volatile oils attach themselves to the metalliferous particles in preference to the gangue.

The oiled metalliferous particles resulting from either of the processes above described have the power of attaching to themselves with a greater comparative strength than the gangue particles the films or bubbles of gas which exist in the mass and are thus raised to the surface of the liquor by gaseous flotation. They can then be removed by skimming or other suitable means. The gangue particles unwetted by oil or grease are not floated up with the oiled mineral particles, and thus in the main remain at the bottom of the vessel containing the mixture. The oil can then be removed from the oiled mineral by any suitable known means.

In the case in which oil-spray is used the temperature of the mass of pulp may be varied to secure the best results with spray of oils of varying viscosity. Instead of suspending the oil-spray in an air-supply system suitably-devised atomizing-jets operated by air or a jet of steam and air may be introduced directly into the pulp. The gas used may be other than air, such as carbonic acid, steam, or mixtures of these. We have also found that a particle of metalliferous mineral if coated with a minute film of oil, grease, or the like then exposed to air will not readily sink in water. It is therefore unnecessary in some instances to employ gaseous bubbles to effect flotation. For example, according to an alternative method for effecting the separation of metalliferous matter from gangue the metalliferous ore-pulp is intimately mixed

in any suitable manner with a small proportion of oil and then sprayed in as finely divided a state as necessary through air by means of jets, revolving disks, or otherwise, and the sprayed product is then allowed to fall upon the surface of water. The gangue particles wetted only with water at once sink, while the metalliferous particles coated with a thin film of oil and after exposure to air float on the surface of the water and may be removed by skimming or other suitable means. Before bringing the pulp into the necessary contact with air it will be obvious that the bulk of the water may first be removed by subsidence or any other suitable means.

In the accompanying drawings, Figure 1 is a diagram in longitudinal section of an apparatus suitable for carrying out this process. Fig. 2 is a diagram in perspective, partly in section, of another form of suitable apparatus; and Fig. 3 is a diagram in perspective, partly in section, of an alternative form of apparatus.

Referring to Fig. 1, A is a tank for pulp, which delivers through a pipe A′ to a concentrating-tank B, the bottom of which slopes downward from the inlet. The tank B is provided at the bottom with a coiled pipe B′, suitably perforated, supported in bearings B^2, and arranged to be rotated by means of a spur-wheel B^3 or the like. Air is forced into this pipe B′ through a pipe C, and oil is simultaneously introduced into the pipe C from carbureter or the like C′. At the end of the tank B farthest from the pulp-inlet a launder B^4 is placed to receive the discharge of floating material, and an outlet-tap B^5 is provided at the lowest point of the tank.

Referring to Fig. 2, D is a tank in which pulp and oil are mixed, and the mixture passes through an outlet-tap D′ to an ejector E, through which air under pressure is passed by the pipe E′. The spray of pulp, oil, and air falls into a tank F, filled with water and consisting of a series of communicating pointed boxes, which increase in depth from the inlet end. A launder F′ is provided at the outlet end of the tank, and outlet-taps F^2 are placed at the lowest points of the boxes.

Referring to Fig. 3, G is a tank in which pulp and oil are mixed. H is a circular disk attached to a vertical spindle H′, supported in bearings H^2 and arranged to be rotated through a driving-pulley H^3 or the like. Surrounding the spindle is a cylindrical collar J, connected with the tank G by a pipe J′, so that the pulp and oil are fed through the collar to the rotating disk. Surrounding the disk is a series of annular pointed troughs K, communicating with one another and increasing in depth toward the outside and filled with water. A launder K′ is provided at the periphery of the outside trough to receive the discharged floating material, and outlet-taps K^2 are placed at the lowest points of the troughs.

This process has been described as applied to ore concentration by oil; but it is to be understood that it is equally applicable to concentration by the use of any other substance which has an affinity for metalliferous matter.

We claim—

1. The herein-described process of concentrating ores which consist in bringing the pulp into intimate contact with "oil" in the form of spray and with a gas and thereafter separating the metalliferous constituents from the gangue.

2. The herein-described process of concentrating ores which consists in bringing the pulp into intimate contact with "oil" disseminating the mixture through air and thereafter separating the metalliferous constituents from the gangue in water.

In testimony whereof we have signed our names to this specification in the presence of two subscribing witnesses.

HENRY LIVINGSTONE SULMAN.
HUGH FITZALIS KIRKPATRICK-PICARD.

Witnesses:
CLAUDE C. R. MCKENZIE,
WALTER J. SKERTEN.

UNITED STATES PATENT OFFICE.

ALFRED SCHWARZ, OF NEW YORK, N. Y., ASSIGNOR TO SCHWARZ ORE TREATING COMPANY, OF PHŒNIX, ARIZONA TERRITORY, A CORPORATION OF ARIZONA TERRITORY.

PROCESS OF CONCENTRATING ORES.

No. 807,501. Specification of Letters Patent. Patented Dec. 19, 1905.

Application filed April 19, 1905. Serial No. 256,487.

To all whom it may concern.

Be it known that I, Alfred Schwarz, a subject of the Emperor of Germany, and a resident of the borough of Manhattan, city, county, and State of New York, have invented certain new and useful Improvements in Processes of Concentrating Ores, of which the following is a specification.

In the concentration of ores by the employment of hydrocarbons as adhesive agents it has been observed that sulfids yield better results than oxids, carbonates, and chlorids. In fact, so far as known to me, a practical application of such process before my inventions relating to this art has been largely, if not wholly, confined to sulfid ores.

The object of the present invention is to extend the application of hydrocarbon concentrating processes to ores heretofore considered unworkable by first converting such ores into sulfids, preferably by a wet method, to thereby preserve the mass of ore in its crushed condition and suitable for treatments according to known methods.

In carrying out the present invention I proceed by preparing a soluble sulfid in any well-known manner—for example, by dissolving sulfur in an aqueous solution of potassium or sodium hydrate, the sulfur being added in sufficient quantity to give the desired reaction. The pulverized ore containing the mineral in the form of oxid, carbonate, or chlorid is then mixed in a suitable vessel with the sulfid solution, the mass being either cold or heated by suitable means and the vessel provided with an agitator to effect a thorough and intimate mixture. During this operation the oxid, carbonate, or chlorid is converted into a sulfid by the action of the potassium or sodium sulfid, a form which is capable of subsequent practical treatment with hydrocarbons for the separation of the values from the earthy or rocky constituents of the ore. As the action of the hydrocarbon on the metallic constituents of the ore is a surface action, it is unnecessary to proceed so far as to convert the entire mass of the particles of oxid, carbonate, or chlorid into a sulfid, it being sufficient if the surface of the particles is so converted, as thereby there is presented all that is necessary for the desired action of the hydrocarbon.

After the initial conversion, as above described, the ore may be concentrated by any suitable treatment with a hydrocarbon, and for such purpose I may use a hydrocarbon which is normally liquid or one which is solid at normal temperatures, or the latter in admixture with the former, as described in my applications Serial Nos. 210,137, 210,138, 225,370, and 231,395, and United States Patent No. 771,277. Of hydrocarbons which are solid at normal temperatures and required to be melted there may be used paraffin or ozocerite, or a resinous hydrocarbon, such as resin, pitch, or asphaltum. Of normally liquid hydrocarbons there may be used any suitable vegetable, animal, or mineral oil. These hydrocarbons may be used singly or in combination of two or more, it being understood that the constitution of the adhesive agent will depend upon the character of the ore to be treated, varying as the ore varies.

Ore either in a dry or wet condition is mixed in any suitable vessel having an agitator with the hydrocarbon, sufficient quantity being added to effect the desired separation. If the hydrocarbon is one which is solid at normal temperatures, it is first melted and then stirred in with the ore, the mixture being effected by any suitable mechanical means and, if desired, air, steam, or gas may be injected into the mass either alone or to assist the mechanical agitation. The injection of such gaseous agent results in the hydrocarbon taking up an appreciable quantity of air or gas, giving a certain sponginess which increases its floating power.

As a specific example of my invention I have used as an adhesive agent a mixture of paraffin and resin, heat being employed if necessary to maintain this compound in a melted condition after it has been mixed with the ore.

After an intimate mixture with all parts of the ore has been effected the mass is subjected to the action of water heated to any desired temperature, even as high as the boiling-point, whereby the earthy or rocky constituents are liberated and washed out and settle in the bottom of the vessel. The metallic constituents of the ore having united with the adhesive agent may be skimmed or

screened off and run to a centrifugal drier for the separation or recovery of the concentrates from the adhesive agent.

Instead of subjecting the mass to the action of heated or boiling water cold water, preferably under pressure, may be injected into the mass, the effect of which is to solidify or granulate the adhesive agent, which with the entrapped metallic constituents may be floated or screened off, while the tailings being saturated with water will be precipitated more or less completely to the bottom of the vessel. By subjecting the mass to heat in a suitable vessel the adhesive agent is melted and the concentrates may be separated and recovered therefrom by a centrifugal drier, filter-press, or other means. The mass of ore and adhesive agent may first be treated with heated or boiling water and subsequently treated with cold water. Also during the treatment with water, which may be made acid or alkaline, if desired, the mass may be agitated mechanically or by the injection of air, steam, or gas.

The concentrates, if necessary, may be washed with a solution of potassium or sodium hydrate to remove any remaining portions of the adhesive agent.

While I have described in giving a specific method of procedure the use of a mixture of paraffin and resin, I may use either one of these singly, the successive steps of the operation being the same, or I may use singly a normally liquid hydrocarbon, following the same method of operation except in such case there will of course be no solidification or granulation of the hydrocarbon. When using a normally liquid hydrocarbon, the mass may be treated either with cold or heated water to effect the separation of the adhesive agent with the metallic constituents of the ore from the tailings.

The essential feature of the present invention is the conversion of an ore of the character above specified into a sulfid to adapt it for treatment by a hydrocarbon, the particular method of concentrating by the employment of a hydrocarbon being varied according to known methods as may be desired or suitable to the particular ore, and while I have given specific examples I do not wish to be wholly restricted thereto.

In carrying out the conversion above described I use an excess of sulfur above the theoretical quantity necessary to effect the change of oxid, carbonate, or chlorid to sulfid.

What I claim, and desire to secure by Letters Patent, is—

1. The method of treating ores which consists in subjecting a non-sulfid ore to the action of a soluble sulfid to convert the mineral into a sulfid, then treating the mass with a hydrocarbon and finally separating the hydrocarbon with the entrapped metallic constituents of the ore from the tailings

2. The method of treating an ore containing non-sulfid mineral by subjecting the same to the action of an alkaline sulfid to convert the mineral into a sulfid, then treating the mass with a hydrocarbon and finally separating the hydrocarbon with the entrapped metallic constituents of the ore from the tailings.

3. The method of treating an ore containing non-sulfid mineral by subjecting the same to the action of an aqueous solution of potassium or sodium sulfid to convert the mineral into a sulfid, then treating the mass with a hydrocarbon and finally separating said hydrocarbon with the entrapped metallic constituents of the ore from the tailings.

4. The method of treating an ore containing non-sulfid mineral by subjecting the same to the action of a soluble sulfid, then treating the resulting metallic sulfid with a melted hydrocarbon which is solid at normal temperatures and finally separating said hydrocarbon with the entrapped metallic constituents from the tailings.

5. The method of treating an ore containing non-sulfid mineral by subjecting the same to the action of a soluble sulfid, then treating the resulting metallic sulfid with a compound of melted paraffin and resin, then separating said compound with the entrapped metallic constituents from the tailings.

In testimony whereof I have hereunto signed my name in the presence of two subscribing witnesses,

ALFRED SCHWARZ.

Witnesses:

E. F PORTER,

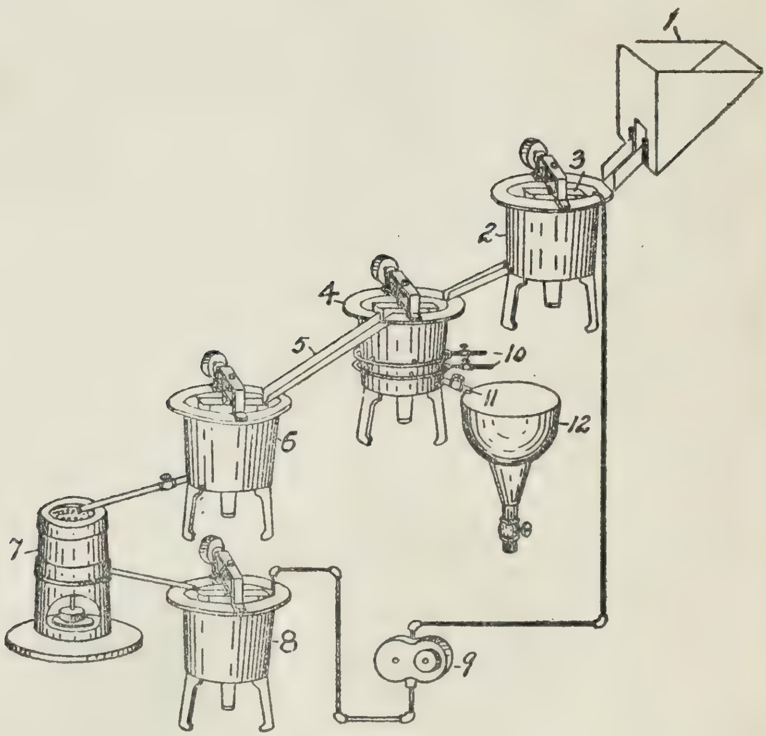
ALEXANDER RODMAN

No. 807,503. PATENTED DEC. 19, 1905.

A. SCHWARZ.

PROCESS OF CONCENTRATING ORES.

APPLICATION FILED MAY 27, 1904.



WITNESSES.

Grace L. Healy

Harry Schnaye

INVENTOR

Alfred Schwarz

BY

Charles D. Jones.

His ATTORNEY

UNITED STATES PATENT OFFICE.

ALFRED SCHWARZ, OF NEW YORK, N. Y., ASSIGNOR TO THE SCHWARZ ORE TREATING COMPANY, OF PHŒNIX, ARIZONA TERRITORY, A CORPORATION OF ARIZONA TERRITORY.

PROCESS OF CONCENTRATING ORES.

No. 807,503. Specification of Letters Patent. Patented Dec. 19, 1905.

Application filed May 27, 1904. Serial No. 210,138.

To all whom it may concern:

Be it known that I, ALFRED SCHWARZ, a subject of the German Emperor, and a resident of the borough of Manhattan, city, county, and State of New York, have invented certain new and useful Improvements in Processes of Concentrating Ores, of which the following is a specification.

My invention has for its object the concentration of ores by the selective action of a hydrocarbon compound.

Heretofore the separation of the values in ores has been effected by mixing the pulverized ore with a product resulting from the distillation of petroleum, the ore having been previously mixed with sufficient water to form a freely-flowing pulp. The oil in such method exercises the property of attaching itself to and buoying up the metallic constituents of the ore that are suspended in the pulp; but it has little or no effect upon the earthy constituents. I have found that the efficiency of the selective action of oils generally, either mineral, vegetable, or animal, is increased by the addition thereto of a fatty matter which is solid at normal temperatures, as paraffin, stearin, or palmitin.

In carrying out my invention I proceed as follows: The ore is first crushed and screened to a convenient size for working and is then thoroughly and intimately mixed with the selective material, which in this instance is a compound of a mineral, vegetable, or animal oil and a fatty matter of the character above specified, such mixture being solid at normal temperatures. Such material may be readily prepared by dissolving the fatty matter in the oil medium, heat being employed to melt the fatty matter, if necessary, and to maintain the compound in a liquid condition during its incorporation with the pulverized ore. As a specific example of a selective material I prefer crude petroleum or any of its products, to which is added about nine to ten per cent., by weight, of paraffin, such proportion having been found to give good results with a copper-sulfid ore.

Any suitable apparatus may be employed to effect the mixture of the ore and selective material, all that is essential being a vessel provided with agitating-blades. In such vessel the ore is mixed with sufficient of the selective material to make a thick pasty mass, the agitation being continued long enough to bring the selective material into intimate contact with all portions of the ore. The vessel may be steam-jacketed or otherwise suitably heated if found necessary to maintain the selective material in a liquid condition. After a complete incorporation of the selective material with the ore water, preferably under pressure, is injected into the mass by suitably-arranged pipes and agitation continued until the water is distributed throughout the mass. The mass is then allowed to subside, when the selective material, with the entrapped metallic constituents of the ore, will rise to the top and may be removed in any suitable manner, as by floating over the top of the vessel. The values may be separated from the selective material in any suitable or well-known manner—as, for example, by a centrifugal drum or filter-press. The tailings, being unaffected by the selective material, will remain in the water and settle to the bottom of the vessel, from which they may be drawn off and, if necessary, subjected to further treatment for the recovery of any values they may contain.

In the concentration of ores by the selective action of the compound above described the action is facilitated and better results secured by the injection of a gaseous fluid—such as air, steam, or gas as carbon-dioxid gas—into the mass. This may be done by suitably-arranged pipes leading into the bottom or sides of the vessel, the effect of such use of air, steam, or gas being to break up and subdivide the mass in a complete and thorough manner. Furthermore, it results in the selective material taking up an appreciable quantity of air or gas, giving a certain amount of sponginess, which increases its floating power. After the admission of water, which may be done by suitably-arranged pipes, the admission of air, steam, or gas may be continued to assist in distributing the water throughout the mass and to effect a thorough separation and washing out of the tailings.

In referring to paraffin as a "fatty matter" it is to be understood that I do so in a popular and not a chemical sense. It is also to be understood that the proportions of the ingredients of the selective material may be varied to suit the particular ore treated.

The accompanying drawing shows in perspective one arrangement of apparatus by which the process may be carried out.

1 designates a bin or hopper from which the pulverized ore is discharged into a vessel 2, which is preferably steam-jacketed and provided with an agitator 3. In this vessel the ore and selective agent are intimately mixed, and from said vessel the mass is discharged into a vessel 4, provided with an agitator in which it is treated with water slightly acidulated, if desired, to effect the separation of the selective agent, with the entrapped metallic constituents, from the tailings. If cold water is employed, the selective agent will be solidified and rising to the top is conducted by a trough 5 to a remelting and storage vessel 6. If heated or boiling water is employed in the vessel 4, the selective agent will be maintained in its liquid condition and as it rises with the entrapped metallic constitutents is run by the trough 5 into the storage vessel 6 and from the latter to a centrifugal-drum 7 for the separation of the values from said agent. The recovered agent is collected in a storage vessel 8, from which it may be raised to the mixing vessel 2 by a pump 9. The separating vessel 4 is provided with suitable pipes 10 for the admission of air, steam, or gas and with a pipe 11 by which the tailings may be discharged into a vessel 12. After removal of the values from the separator 7 they may be subjected to any suitable treatment.

What I claim, and desire to secure by Letters Patent, is—

1. The process of concentrating ores consisting in mixing with the pulverized ore a selective agent consisting of a mixture of a liquid hydrocarbon and a normally solid fatty matter which mixture is solid at normal temperatures, separating said agent with its entrapped values from the tailings, and finally recovering the values from the selective agent.

2. The process of concentrating ores consisting in mixing with the pulverized ore a selective agent consisting of a mixture of a liquid hydrocarbon and a normally solid fatty matter which mixture is solid at normal temperatures, treating the mass with water to separate said agent with its entrapped values from the tailings, and finally recovering the values from the selective agent.

3. The process of concentrating ores consisting in mixing with the pulverized ore a selective agent consisting of a mixture of a liquid hydrocarbon and a normally solid fatty matter which mixture is solid at normal temperatures, treating the mass with cold water to separate said agent with its entrapped values from the tailings, and finally recovering the values from the selective agent.

4. The method of concentrating ores consisting in mixing with the pulverized ore a selective agent consisting of a mixture of a liquid hydrocarbon and a normally solid fatty matter which mixture is solid at normal temperatures and subjecting the mass to the action of a gaseous fluid, separating the selective agent with its entrapped values from the tailings, and finally recovering the values from the selective agent.

5. The process of concentrating ores consisting in mixing with the pulverized ore a selective agent consisting of a mixture of a liquid hydrocarbon and paraffin which mixture is solid at normal temperatures, separating said agent with its entrapped values from the tailings, and finally recovering the values from the selective agent.

6. The process of concentrating ores consisting in mixing with the pulverized ore a selective agent consisting of a mixture of a liquid hydrocarbon and paraffin which mixture is solid at normal temperatures, treating the mass with water to separate said agent with its entrapped values from the tailings, and finally recovering the values from the selective agent.

In testimony whereof I have hereunto signed my name in the presence of two subscribing witnesses.

ALFRED SCHWARZ.

Witnesses:
E. F. Porter,
Charles S. Jones.

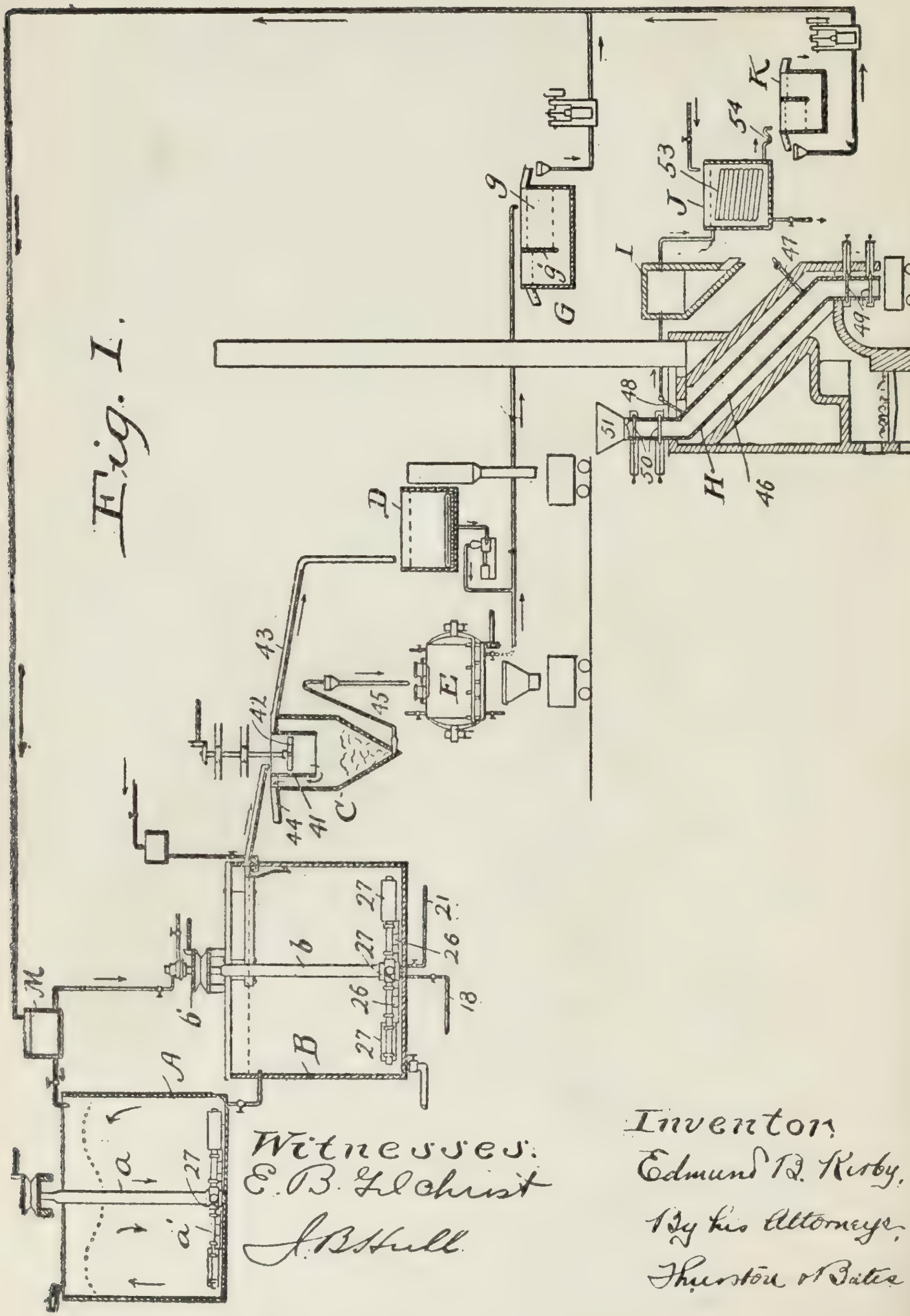
No. 809,959. PATENTED JAN. 16, 1906.

E. B. KIRBY.

PROCESS OF SEPARATING MINERALS.

APPLICATION FILED DEC. 14, 1903.

3 SHEETS—SHEET 1.



Witnesses:
E. B. Gilchrist
J. B. Hull

Inventor,
Edmund B. Kirby,
By his Attorneys,
Thurston & Bates

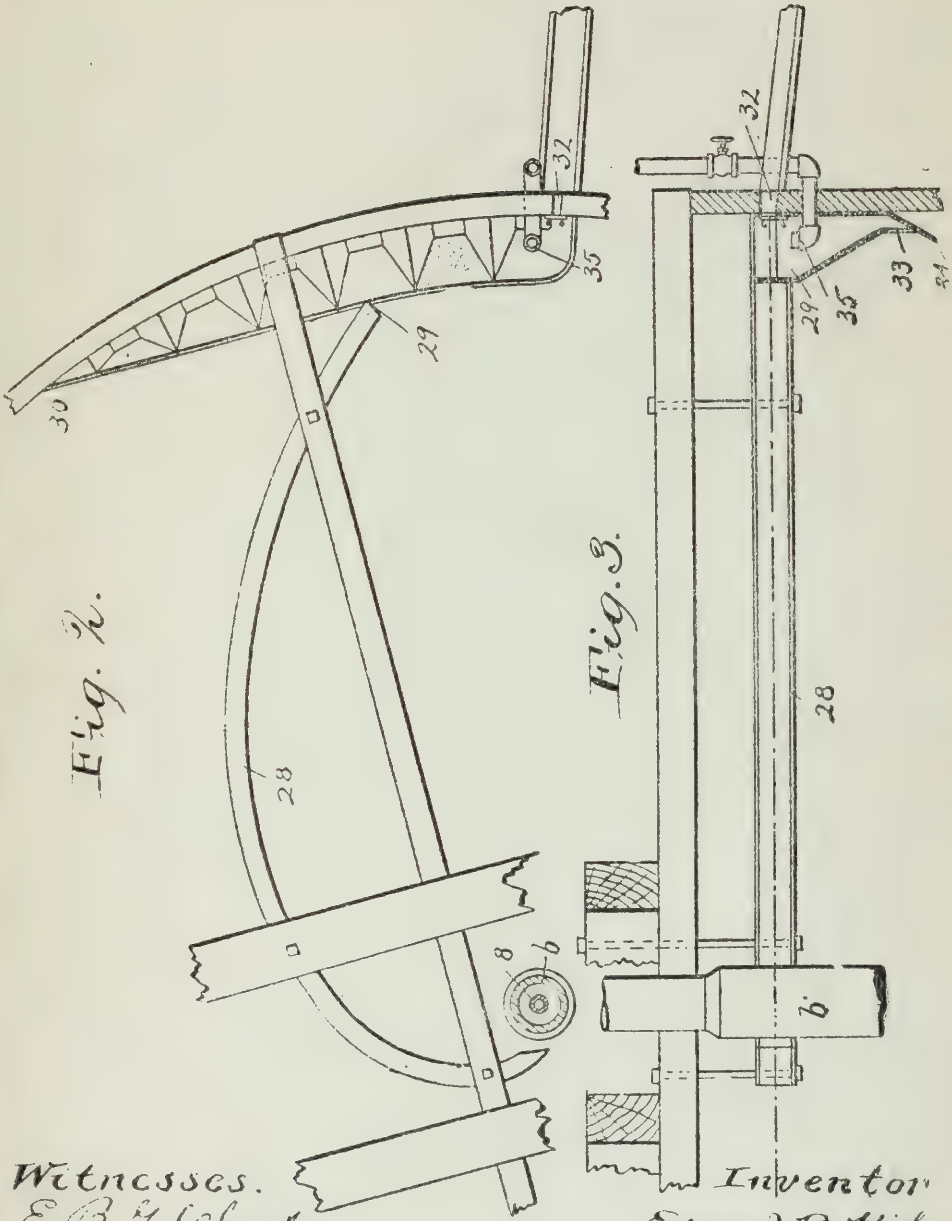
No. 809,959 PATENTED JAN. 16, 1906.

E. B. KIRBY.

PROCESS OF SEPARATING MINERALS.

APPLICATION FILED DEC. 14, 1903.

3 SHEETS—SHEET 2.



Witnesses.
E. B. Gilchrist
J. B. Hull

Inventor
Edmund B. Kirby,
By his Attorneys,
Thurston & Bates

No. 809,959. PATENTED JAN. 16, 1906.

E. B. KIRBY.

PROCESS OF SEPARATING MINERALS

APPLICATION FILED DEC. 14, 1903.

3 SHEETS—SHEET 3

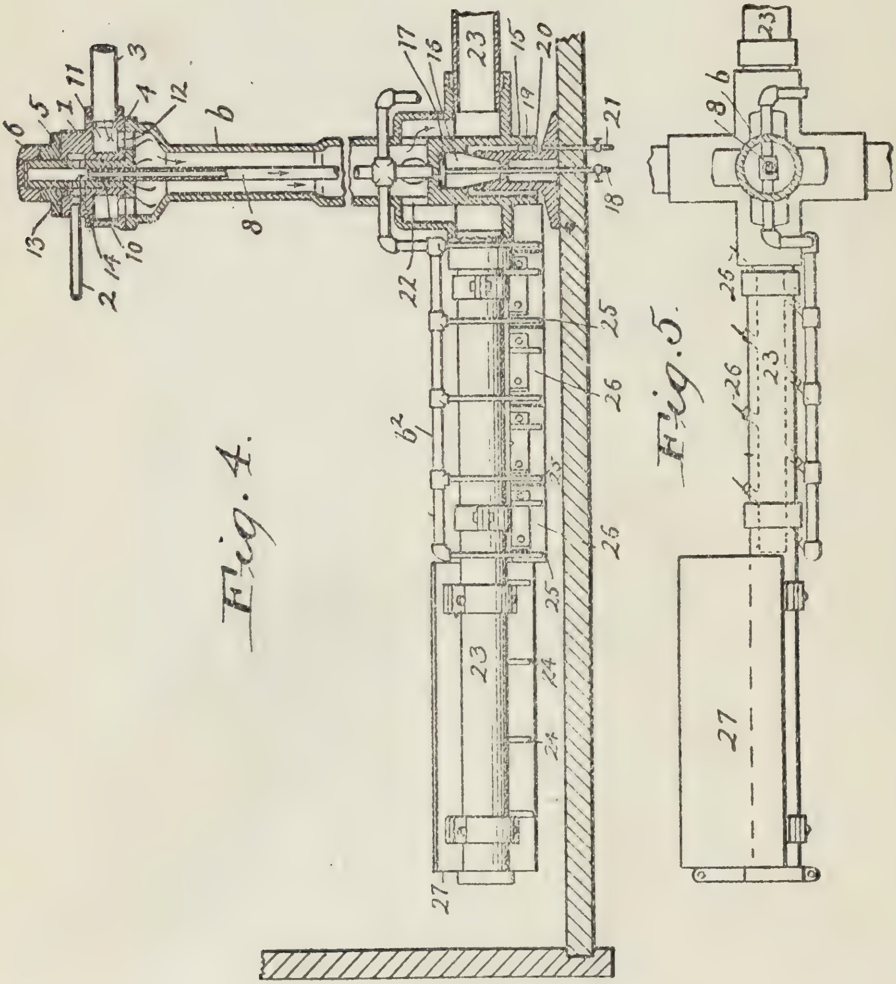


Fig. 4.

Fig. 5.

Witnesses.
E. B. Gilchrist
J. B. Hull

Inventor:
Edmund B. Kirby,
By his Attorneys,
Thurston & Bates

UNITED STATES PATENT OFFICE.

EDMUND B. KIRBY, OF ROSSLAND, CANADA.

PROCESS OF SEPARATING MINERALS.

No. 809,959. Specification of Letters Patent. Patented Jan. 16, 1906.

Application filed December 14, 1903. Serial No. 185,033.

To all whom it may concern:

Be it known that I, EDMUND B. KIRBY, a citizen of the United States, residing at Rossland, in the Province of British Columbia and Dominion of Canada, have invented a certain new and useful Improvement in Process of Separating Minerals, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings.

The invention relates to the concentration of ores. It may be employed to separate the metallic minerals from the gangue, or to separate certain of the metallic minerals from others, or from others and the gangue.

The operation of the process is dependent upon the fact that, because of differences in physical characteristics of the various constituents of mineral material, such constituents show preferences of adhesion between two commingled, but immiscible liquids.

The invention consists in the process hereinafter described, and in the several steps thereof, all of which will be definitely set forth in the claims.

In the drawings, Figure 1 is a diagrammatic view of an apparatus with which the process may be practiced, the several parts thereof being shown in vertical section. Fig. 2 is a plan view of one side of the separating-tank. Fig. 3 is a vertical sectional view of the same mechanism. Fig. 4 is an elevation of a part of the agitator mechanism of the separating-tank, some of said mechanism being in section; and Fig. 5 is a plan view of one of the agitator-arms and a sectional plan view of the shaft.

The process is applicable to a great variety of ores, and may be practiced in many cases so as to separate those metallic minerals which must be treated in one way from those which must be treated in some other way in order to recover their contained commercial metals, and since it is capable of being used for this purpose as well as to separate the metallic minerals from the gangue it is thought to be a great step in advance of this art.

It is believed that the process or some of the novel steps thereof may be employed with advantage in the treatment of all ores. It is obviously impossible, however, to give definite directions for attaining the best results with all ores, because of the great chemical and physical differences which they exhibit. The detailed directions hereinafter set forth are those which are found most efficient in the treatment of the Rossland, British Columbia, ores, with which I have done the most work, for the primary purpose of separating the chalcopyrite (which must be smelted) from the other constituents which may be subjected to other after treatment for the recovery of their contained metals.

The process, as an entirety, in its best form for use with Rossland ores for the purpose stated consists in the following steps:

First, in thoroughly agitating together (*a*) the pulverized ore or mineral material (*b*) enough water to make with said pulverized ore a flowing pulp, and (*c*) a solution of bitumen in a thin distillable hydrocarbon liquid as kerosene, these materials to be so thoroughly agitated together as to finely subdivide said solution into small globules and bring said globules into contact with substantially all of the pulverized mineral particles which will, by preference, adhere to them.

Second, in allowing the hydrocarbon-coated particles to float to the surface of the mass, and in rendering this separation substantially complete by gently agitating the mass, and by injecting gas into the same, and preferably also discharging into the mass fine streams of the solution. When the separation is completed, the floating hydrocarbon-coated concentrate is removed for subsequent treatment.

Third, in filtering said concentrate to free it so far as possible from the hydrocarbon liquid.

Fourth, in distilling said coated concentrate and condensing the hydrocarbon vapor to be used again.

It is thought that the use of a gas to assist in the flotation of the coated particles, as set forth in the description of the second step of the process, is radically new in this art, irrespective of its association with the other steps described. It is that which makes it possible for the first time to use thin oils and hydrocarbon. The prior processes which use thick, viscous oils will, however, be much aided by the addition of this step, because in spite of all the care which is exercised in the practice of those processes to keep the oil in large clots or masses a great deal of it is "floured" or broken up into minute particles which are trapped in the sands and lost. The employment of the gas in the manner stated brings in a more powerful floating agency than anything before used, which results in the recov-

ery of this floured oil together with numerous coated particles which would not otherwise be floated. This step of the process is therefore useful with any and all liquids lighter than water which exhibit preference of adhesion for the metallic mineral particles. Kerosene alone, for example, may be used with most ores to take out the sulfids provided the gas is used, as stated, to cause the flotation of the kerosene-coated particles. It is the bitumen, however, dissolved in the kerosene which gives the precise adhesive preference which enables it to separate the gold and chalcopyrite from the crushed ore. The bitumen may be asphalt or the bitumen produced by the distillation of petroleum to a semisolid residuum, or it may be tar, pitch, or any other specific form of bitumen. In treating Rossland ores I have found that the most satisfactory results have been attained by using a solution obtained by dissolving in kerosene about five per cent. or thereabout of Trinidad asphalt or the semisolid residuum of petroleum distillation. Preferably the pulverized ore is mixed with three to five times as much water, by weight, and to this is added a sufficient amount of the kerosene-bitumen solution, excellent results being obtained by using one-fourth to three-fourths as much, by weight, as ore. The preference of the solution for some of the mineral particles may be regulated by altering or varying the quantity of the solute substance and by varying the temperature at which the solution is used. The preference of the water for other mineral particles may be regulated by adding some acid or other chemical. A distinct advantage of using a light hydrocarbon, like kerosene, is that so much of it as cannot be removed from the concentrate by mechanical means may be recovered by a process of distillation, this method of recovery being impossible when thick non-distillable oils are used. The injection of a gas, preferably air, into the mass, which is the chief novel characteristic of the second step of the process, assists in the flotation of the hydrocarbon-coated particles. This makes it possible to finely subdivide the solution by the agitation, and this greatly increases the chance that all of the mineral particles which exhibit preferential adhesion for it shall be brought into contact with it. Some of the hydrocarbon-coated particles will float to the surface without assistance; but a considerable quantity of such particles will not be sufficiently buoyant, and some of such particles and some globules of the mixture would be trapped in the sands. In order to recover this less buoyant material together with the globules of the mixture, the mass which tends to settle is slowly lifted and turned over to liberate the coated particles and the globules, and at the same time a gas, preferably air, is blown into the mass preferably near the bottom thereof. The air-bubbles not only tend to attach themselves directly to the coated particles, and thus float them to the surface, but the air becomes dissolved in the water to its maximum capacity. This dissolved air tends to again separate itself from the water and attach itself in minute globules to the coated particles. I find that air, carbon dioxid, hydrogen, and marsh-gas are satisfactory for this purpose, and doubtless many other or all gases will operate in the same way, but I prefer air. It might be here added that because the solution is broken up into small globules there is little likelihood that any of the non-coated particles shall be entangled with the coated concentrates and carried to the surface. In removing this floating hydrocarbon-coated concentrate it is practically impossible to exclude some of the water in which the non-coated particles are held in suspension. It is therefore desirable that this concentrate shall be washed free from such non-coated minerals. This step is not, however, absolutely essential. It is possible to remove a very large part of the hydrocarbon by filtration, because of its thin character. It is not, however, possible to remove it all by this or any other mechanical process; but because of the character of the hydrocarbon solvent used it is possible to recover all of it for future use by a process of distillation which constitutes the fourth step of the complete process.

I will now describe the apparatus shown in the drawings for practically carrying on said process.

A represents the mixing-tank.

B represents the separating-tank.

C represents the settling-tank.

D represents the filter, and E another filter, which may or may not be used according to circumstances.

G represents a settling box or tank into which the liquid from the filter or filters is discharged.

H represents the retort-furnace; I, the dust-collector used in connection therewith; J, a condenser; K, the settling-tank, in which the condenser discharges the condensed vapor, and M represents a reservoir from which the solution may be fed into the mixing-tank and into the separating-tank.

In the separating-tank B is a vertical shaft b, having on its upper end a gear b', by which it may be rotated. The head of the shaft above the driving-gear passes through an oil and air box 1, which remain stationary while the shaft revolves and is supplied by the hydrocarbon-pipe 2 and the air-pipe 3. The box rests on the rotating shoulder 4 of the shaft and is held down to a tight joint by the collar 5 and lock-nut cap 6. Through the hollow shaft 7 extends a small hydrocarbon-pipe 8, the upper end of which is firmly inserted within the upward extension 10 of the

shaft, and this central pipe conveys the hydrocarbon. In the stationary box the air enters the annular chamber 11, passing through its open bottom through a set of apertures 12 to the interior of the shaft. The hydrocarbon enters a similar annular chamber 13, from which it passes by apertures 14 into the top of the central hydrocarbon-pipe. The hub and revolving arms are shown in Figs. 4 and 5. The step-bearing is supported on a pedestal 15, provided with a wooden block 16, which supports the moving wearing-plate 17 of the shaft. Lubricating-water under pressure is introduced through the pipe 18, finding its way out from the bearing through side grooves 50. The sides 19 of the shaft are carried down below the bearing, so as to leave an annular space 20 between them and the pedestal. This annular space is intended to constitute an air-bell designed to assist the lubricating-water in excluding sand from the bearing. The air-supply in it is maintained by a slight stress of air which escapes beneath the bell through the pipe 21. The air-current for the charge passes down through the shaft, passing (as shown by the arrows) through the side channels 22 into the hollow arms 23 23. From each arm it passes out through drop-pipes 24 24. The hydrocarbon liquid is delivered through small pipes parallel with said hollow arms, emerging at the outlets 25 25. The radially-scraping blades 26 26 are secured to the arms 23 and also the inclined lifting-plow 27 at the extremity of the said arms, this being so set as to force the circulation upward at this point. The rotary movement of the charge leads the floating scum of hydrocarbon liquid, air-bubbles, and concentrates against the curved skimming-bar 28, which is hung so as to arrest and deflect this floating layer and cause it to pass into the settling and washing chamber or box 29. The edge of this box outside of the skimming-bar is submerged sufficiently to allow the floating material to pass over it, while the remaining part of said edge is raised above the liquid, so as to detain everything passing into it. Owing to the agitation within the tank caused by the movement of the arms 23 and the rising air-bubbles the water, even near the top, is not clear, but turbid or muddy, with slimes or fine particles of the non-coated minerals which do not settle rapidly enough to get out of the way. The floating concentrates are carried mainly at the lower surface of the hydrocarbon layer, where it is in contact with the water. The discharge-gate 32 in order to permit these floating particles to pass out must be set low enough to clear them, and must therefore allow a portion of the water to pass out with the skimmings, and this muddy water would therefore carry its suspended particles of the worthless minerals, which would make the concentrates impure. The settling and washing chamber or box is designed to lessen or prevent this evil. As the floating material passes over its submerged edge 29 30 it escapes from the swift current and rising air-bubbles, so that in its comparative quiet the slimes have a better opportunity to settle out of the way. The bottom of the box is divided as convenient into compartments by submerged partitions, as shown, each compartment terminating in a hopper-shape bottom with discharge-openings 33, through which the settled slimes may pass out again into the tank. Projecting shields 34 prevent the air-bubbles from entering the hoppers and disturbing their quiet. The passage of the floating material over this quiet chamber or box settles most of the slime before reaching the adjustable discharge gate or outlet 32. Before reaching the gate, however, the skimmings pass over a stream of clean wash-water introduced at the point 35 through the pipe shown. This wash-water is delivered under constant head from a supply-tank. Its quantity is made exactly equal to that passing out through the discharge-gate with the skimmings, so that this discharge, being supplied entirely by the pure water close at hand, contains little or none of the muddy water which is thus held back in the tank. It is evident that the incoming and outgoing streams are self-adjusting, because if too much enters the general level rises and a larger stream flows from the orifice.

In the mixing-tank a vertical rotating shaft *a* is mounted having, preferably, a lower bearing similar to that which is provided for shaft *b* and which has been described. Arms *a'* are attached to the shaft near its lower end, and lifting-plows are secured to the outer parts of these arms and radial plows to the other parts thereof, just as in the separator-tank. This shaft *a* is to be rotated rapidly, and the result is a thorough commingling of the various parts of the charge, which result is facilitated by the currents created in the charge by the action of said plows, the direction of said currents being indicated by the arrows in Fig. 1. This separate-tank for performing the mixing operation is not necessary for my process, although it is preferable in some cases, as when a continuous discharge is desired. The mixing may be performed just as well in the separating-tank, which may then be termed the "mixing" and "separating" tank. It is merely necessary to rotate the agitating mechanism rapidly while mixing and to rotate it slowly while the separation is being made.

The material skimmed from the surface of the separating-tank may pass directly to the filter D or E; but it is best to discharge it into the settling-tank C in order to separate the

main bulk of water, and thus reduce the bulk of liquid to be put through the filtering operation As explained, this is not essential, but is conveniently introduced prior to the filtration merely in order to separate the main bulk of water, and thus reduce the bulk of fluid to be put through the filtering operation It is thus merely a convenience. The settling-tank C is shown as a cylindrical vessel with hopper-shape bottom, within which is suspended a cylinder 41, reaching half-way down The stream of skimming enters this central cylinder, within which the water and hydrocarbon separate, the former sinking, while the latter, with its accompanying concentrates and air-bubbles, floats in a layer, as shown. The stirring apparatus 42 has its arms revolving gently within this layer, so as to break up and discharge air-bubbles and assist the separation. Most of the concentrates hang near the contact between the hydrocarbon and water, and as this contact-surface becomes overloaded with concentrates some of them sink to the bottom of the tank. The excess of hydrocarbon, accompanied by some of the concentrates, flows out through the launder 43, while the excess of water passing beneath the suspended internal cylinder passes out through the overflow 44, and thereby lessens the volume to be filtered. The concentrates which fall to the bottom of the tank, accompanied by the hydrocarbon which adheres to them, are drawn off in a thick condition through the pipe 45, the discharge end of which is raised to prevent the exit of more water than necessary. The two streams, one of hydrocarbon and concentrates, the other mainly of water and concentrates, may either be filtered in separate apparatus or united and put through the same apparatus, as is found most convenient. Hydrocarbon liquid and concentrates filter more easily than when water is present, and it may therefore be desirable to filter separately. It is for this reason that two filters D and E are shown, the one receiving such material as flows from the surface of the tank through launder 43 and the other that material which is discharged through pipe 45. I do not restrict myself to any particular form of filtering appliance.

The use of thin hydrocarbon liquid in place of the thick viscid oils used by other inventors makes filtration comparatively easy and permits the use of more simple and cheap methods than the centrifugal machine or filter-presses. The use of such simple apparatus is also made possible by the fact that it is not now necessary to separate the liquid very thoroughly, since its extraction is to be perfected in the distillation-retorts. I find that in some cases it is sufficient to use a simple open filter-tank with a porous bottom of any of the well-known kinds, preferably light canvas, resting on suitable supports. The liquid and water drain through the porous bottom, leaving the concentrates in the tank sufficiently drained to be shoveled into the retorts. The passage of the liquid and water through the porous bottom is aided by the well-known means of a vacuum-pump N beneath. The filter (indicated by E) is a pressure-filter barrel of well-known construction, which need not be here explained, and may be used when forced filtration is necessary. It is shown to emphasize the fact that the operation of the process is not restricted to any specific kind of filter or to any number of filters. The mixture of hydrocarbon liquid and water now free from solid matter is of course self-separating in any receptacle. A convenient form is shown in the settling-box G, into which said mixture is delivered through suitable pipes from both filters. The hydrocarbon liquid remains in one compartment g, from which it overflows and is returned to the reservoir. The water sinking to the bottom passes under the partition g' to the other compartment and flows to waste. The filtered concentrates containing some residual liquid and moisture are now ready for the distilling operation for the recovery of the five per cent. or more of valuable hydrocarbon liquid remaining in them. This is done in the retort-furnace H. An iron retort 46 is set in a furnace at such an angle that the concentrates will pass down through it by gravity, but will not altogether close the upper side of the channel, which should remain more or less open for the exit and passage of the steam and hydrocarbon vapors. The retort is maintained at the distillation temperature of the hydrocarbon used, which in the case of kerosene is about 338° Fahrenheit. In order to assist in carrying off the hydrocarbon vapor, a current of superheated steam is introduced at 47, while the steam and hydrocarbon vapors pass off through the pipe at 48 to the condensing apparatus. The dry concentrates on losing their liquid and moisture slide down to the lower end of the retort, where they are drawn off through the double gates 49 49, which are opened alternately, so as to prevent the escape of vapors. As concentrates are drawn off below a fresh mass is introduced above by the alternate opening of the gates 50 50, which likewise prevent the escape of vapors. An additional seal is provided by the hopper 51, which is kept filled with concentrates. The steam and hydrocarbon vapors may be led through a dust-collecting chamber I, designed to settle and collect any concentrates dust carried over, and then passes to the condenser J. This includes a metal worm or coil 53, set in a tank through which a stream of cooling-water is allowed to flow. The condensed hydrocarbon and water passing through a U-trap 54

flow into a settling-box K, similar to the one described at G. Here the hydrocarbon liquid and water separate, and the former is returned to the reservoir M for reuse, as is also the liquid recovered in the settling-tank G.

Having described my invention, I claim—

1. The process of separating minerals, which consists in mixing together pulverized mineral material, a considerable quantity of water, and a substance immiscible in water, but of less specific gravity, and which will, in the presence of water, adhere to some of the mineral particles and not to others; in violently agitating the mass so as to break up said immiscible substance into minute globules; in allowing said mass to settle whereby a considerable quantity of the mineral particles having become coated with said substance will float to the top of the mass, and in gently agitating the portion thereof which settles, and in blowing into the same a gas for the purpose of assisting the flotation of said substance and the mineral particles coated therewith; in removing the floating layer, and in separating the mineral particles from said immiscible substance, substantially as specified.

2. The process of separating ores, which consists in mixing together pulverized mineral material, a considerable quantity of water, and a solution of bitumen in a light hydrocarbon liquid, the proportion of bitumen in solution being substantially sufficient to insure the coating and entrainment of the mineral particles; in violently agitating this mixture to break up said solution into fine globules; in allowing the mass to settle, and then gently agitating the same and blowing in gas to insure the flotation of said solution and the mineral particles coated thereby; in removing the floating layer; and separating the mineral particles from the solution, substantially as specified.

3. The process of separating ores, which consists in mixing together pulverized mineral material, a considerable quantity of water, and a solution of bitumen in a light hydrocarbon liquid, the proportion of bitumen in solution being substantially sufficient to insure the coating and entrainment of the mineral particles; in violently agitating this mixture to break up said solution into fine globules; in allowing the mass to settle, and then gently agitating the same and blowing into it a gas and some of the said solution to insure the flotation of said solution and the mineral particles coated thereby; in removing the floating layer; and separating the mineral particles from the solution, substantially as specified.

4. The process of separating minerals, which consists in mixing together the pulverized mineral material a considerable quantity of water, and a solution of bitumen in a light hydrocarbon liquid; in allowing the same to settle, and removing therefrom the floating layer of said solution and the mineral particles which have been coated thereby; and in filtering the material so removed, substantially as specified.

5. The process of separating minerals, which consists in mixing together the pulverized mineral material, a considerable quantity of water, and a solution of bitumen in a light hydrocarbon liquid, the proportion of bitumen in solution being substantially sufficient to insure the coating and entrainment of the mineral particles; in gently agitating this mixture and blowing gas into the same to assist the flotation of said solution and the mineral particles which have been coated thereby; in removing said floating layer; and filtering the same, substantially as specified.

6. The process of separating minerals which consists in mixing together the pulverized mineral material, a considerable quantity of water, and a solution of bitumen in a distillable hydrocarbon liquid, the proportion of bitumen in solution being substantially sufficient to insure the coating and entrainment of the mineral particles; in allowing the same to settle, and removing therefrom the floating layer of said solution and the mineral particles which have been coated thereby; in filtering the material so removed; and in distilling the concentrate residue and condensing the hydrocarbon vapors driven off, substantially as specified.

7. The process of separating minerals, which consists in mixing together the pulverized mineral material, a considerable quantity of water, and a solution of bitumen in a distillable hydrocarbon liquid; in gently agitating this mixture and blowing gas into the same to assist in the flotation of said solution and the mineral particles which have been coated thereby; in removing the floating layer, and filtering the same; and in distilling the concentrate residue and condensing the hydrocarbon vapors driven off, substantially as specified.

8. The process of separating minerals, which consists in mixing together the pulverized mineral material, a considerable quantity of water, and a solution of bitumen and kerosene; in gently agitating this mixture, and in blowing a gas into the same to assist in the flotation of said solution and the mineral particles which have been coated thereby; and in separating said solution and mineral particles, substantially as specified.

9. The process of separating minerals, which consists in mixing together the pulverized mineral material, a considerable quantity of water, and a solution of bitumen in kerosene, and in vigorously agitating this

mixture so as to break up said solution into minute globules; in gently agitating said mixture and blowing a gas into the same to assist in the flotation of said solution and the mineral particles coated thereby; in removing the floating layer; in washing and filtering the same; and finally in distilling the concentrate residue and condensing the hydrocarbon vapors driven off, substantially as specified.

In testimony whereof I hereunto affix my signature in the presence of two witnesses.

EDMUND B. KIRBY.

Witnesses:

T. L. SAVAGE,

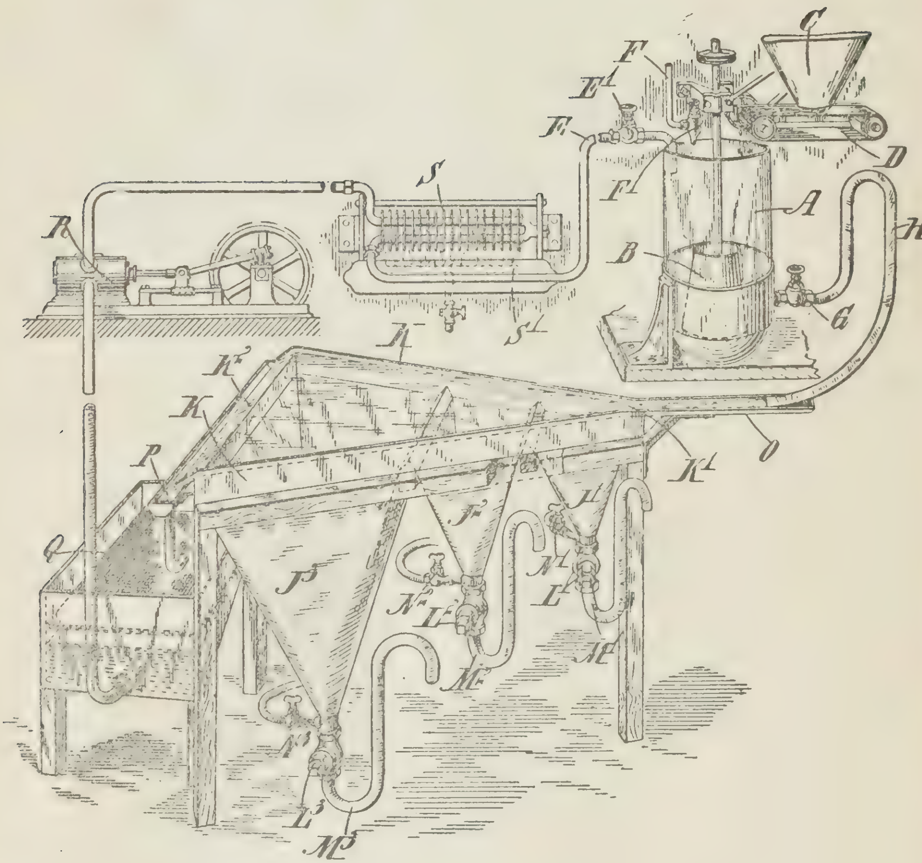
E. G. EASTMAN.

No. 835,143. PATENTED NOV. 6, 1906.

H. L. SULMAN.

ORE CONCENTRATION.

APPLICATION FILED OCT. 20, 1905.



Witnesses
H.A. Totten
[illegible]

Inventor
Henry Livingstone Sulman
by Knight Bros
Attorneys

UNITED STATES PATENT OFFICE.

HENRY LIVINGSTONE SULMAN, OF LONDON, ENGLAND.

ORE CONCENTRATION.

No. 835,143. Specification of Letters Patent. Patented Nov. 6, 1906.

Application filed October 20, 1905. Serial No. 283,704.

To all whom it may concern:

Be it known that I, HENRY LIVINGSTONE SULMAN, a subject of the King of England, residing at London, England, have invented certain new and useful Improvements in Ore Concentration, of which the following is a specification.

This invention relates to improvements in the concentration of ores, the object being to separate metalliferous matter, graphite, and the like from gangue by means of oils, fatty acids, or other substances which have a preferential affinity for metalliferous matter over gangue.

In the process described in the specification of the previous patent application, Serial No. 262,889, filed May 29, 1905, a mineral pulp is agitated with a small proportion of an oily substance, such as oleic acid or petrol or other oil, amounting to a fraction of one per cent. on the ore until the oil-coated metalliferous matter forms into a froth which can be separated from the gangue by flotation, the pulp being acidified. It is also stated that the pulp may be warmed, say, to 30° to 40° centigrade to increase the tendency for the oily substance to disseminate through the pulp and the rapidity with which the metalliferous matter becomes coated.

It is now found that if the finely-powdered ore suspended in water is mixed with a small proportion of an oily substance—say five per cent. or less of the ore—agitated and heated to a high temperature—say, to boiling-point—that is to say, to a temperature at which bubbles of steam or vapor are generated in the pulp—the formation of a froth containing the oil-coated metalliferous matter is considerably promoted, and a very efficient separation of the metalliferous matter from the gangue may thus be obtained.

The water in which the oiling is effected may be slightly acidified by adding, say, a fraction of one per cent. of sulfuric acid or other mineral acid or acid salt, or the water may be neutral or alkaline. It is to be understood that the object of using acid in the pulp according to this invention is not to bring about the generation of gas for the purpose of flotation thereby, and the proportion of acid used is insufficient to cause chemical action on the metalliferous minerals present.

The quantity of oil employed is not sufficient to cause the flotation of the metalliferous matter by the buoyancy of the oil; but the quantity may be sufficient—say five per cent. or less on the quantity of ore—to coat the metalliferous particles with a thin film of oil.

The following is an example of the application of this invention to the concentration of ore: Broken Hill or certain copper ores are finely powdered and mixed with water, acidified or not. To this is added a proportion, as above described, of an oily substance, such as oleic acid, and the mixture is agitated in a cone mixer or the like in order to effect due oiling of the mineral particles. The pulp may now be removed from the agitation (oiling) vessel and subjected to heat in suitable apparatus. As the liquor becomes heated, and especially as the boiling-point of the liquor is approached, a froth or scum rises to the surface containing practically the whole of the metalliferous matter, while the gangue remains in the pulp. The froth may be removed from the liquid by skimming or in any usual way, or the frothy portion may be separated from the remainder of the pulp by causing this to flow through a spitzkasten or the like. The froth after separation and collection may be allowed to subside, and the oily substance may be removed from the metalliferous matter by treatment with an alkali or a solvent or otherwise.

The heating of the pulp may be effected by means of closed steam-coils, or of free steam-jets, or surrounding the agitating vessels with steam-jackets, or by any other suitable means, or the treatment of the pulp by heat may be made continuous by causing it to flow over heated surfaces in a continuous stream and collecting the suitably-heated product in an apparatus wherein the separation of the froth so produced from the mineral-depleted ore-pulp can be effected; or the contents of the agitation (oiling) vessel may be heated to the necessary extent, which approaches the boiling temperature, and on cessation of agitation the mineralized froth rises to the surface.

Should any coarser particles of oiled mineral (unremoved as "froth") remain in the coarse sands of the separated pulp, these particles may be recovered by passage over a concentration or aeration apparatus or the like.

It is to be understood that the details of the process may be varied without departing from this invention.

The accompanying drawing is a perpective view of one form of apparatus suitable for

carrying this invention into practice, the arrangement being such that the contents of the agitation vessel may be heated to the necessary extent.

A mixing vessel A (of which there may be any number in series) is provided with a rotatable stirrer B. Crushed ore is fed from a hopper C into the vessel by a band D. A pipe E, controlled by a tap E′, delivers circuit-water to the vessel, and oleic acid or other oil is introduced through the pipe F and tap F′. The outer cock G from the vessel A communicates, through a swan-neck pipe H, with the froth-separating apparatus.

In passing from the frothing apparatus A to the spitzkasten (say between O and K) the pulp may, if desired, be run in a thin layer over a smooth slightly-inclined plane.

The froth-separating apparatus comprises several (say three) pointed boxes J′ J² J³, which open at the top into a horizontal channel consisting of side walls K. The channel has a narrow inlet K′ and spreads out to a wide outlet K². The pointed boxes J′ J² J³ have full-way cocks L′ L² L³ at the bottom leading to swan-neck discharge-pipes M′ M² M³. An upcurrent of water may be led in at the bottom of each box through a tap N′ N² N³.

The boxes are all filled with circuit-water. The pulp from the vessel A is distributed horizontally from the flat trough O through the inlet K′. The heavy sands and coarser particles of mineral sink into the first box J′, from which they are led to a shaking-table, convex buddle, or the like, to be treated as above described. The middlings or medium sands fall into the box J², and if they contain any mineral may be removed for further treatment by agitation. The upcurrent of water from the taps N′ N² prevents the deposition of any slime in these boxes. The fine sands or gangue slimes settle in the last box J³, from which they are discharged to waste or further treatment.

The slime mineral in the form of froth or scum floats from the liquid and is carried by the stream over the outlet K² into a launder P and thence to a filter Q, where the metalliferous matter is removed from the circuit-water, which is returned to the vessel A by a pump R. The circuit-water may be brought to the proper temperature approximately to boiling-point by passing it through a heater S, having a burner S′, before admitting the water to the vessel A.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. The herein-described process of concentrating ores which consists in mixing the powdered ore with water, adding a small proportion of an oily liquid having a preferential affinity for metalliferous matter, agitating the mixture, heating the mixture approximately to boiling-point until the oil-coated mineral matter forms into a froth and separating the froth from the remainder by flotation.

2. The herein-described process for concentrating ores which consists in mixing the powdered ore with water, adding a small proportion of oily liquid having a preferential affinity for metalliferous matter, agitating the mixture, heating the mixture until gaseous bubbles are generated therein so that the oil-coated mineral matter forms into a froth and separating the froth from the remainder by flotation.

3. The herein-described process of concentrating ores which consists in mixing the powdered ore with slightly-acidified water, adding a small proportion of oily matter having a preferential affinity for metalliferous matter, agitating the mixture, heating the mixture approximately to boiling-point until the oil-coated mineral matter forms into a froth and separating the froth from the remainder by flotation.

4. The herein-described process of concentrating ores which consists in finely powdering the ore, mixing it with slightly-acidified water, adding a small proportion of an oily substance having a preferential affinity for metalliferous matter in quantity insufficient to cause the flotation of the metalliferous matter by the buoyancy of the oil, agitating the mixture, heating the mixture to boiling-point until the oil-coated mineral matter forms into a froth, separating the froth from the remainder by flotation and removing the oil coating from the mineral by a solvent.

5. The herein-described process of concentrating ores which consists in finely powdering the ore, mixing it with water containing less than one per cent. of sulfuric acid, adding a proportion of less than ten per cent. of oleic acid, agitating the mixture until the oleic acid has come into sufficient contact with the mineral, heating the mixture up to boiling-point until the metalliferous matter has been raised in a froth to the surface, running the mixture over a current of water so that the froth is floated away by the current while the remaining mineral sinks, separating the froth and removing the oleic acid therefrom by a solvent.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

HENRY LIVINGSTONE SULMAN.

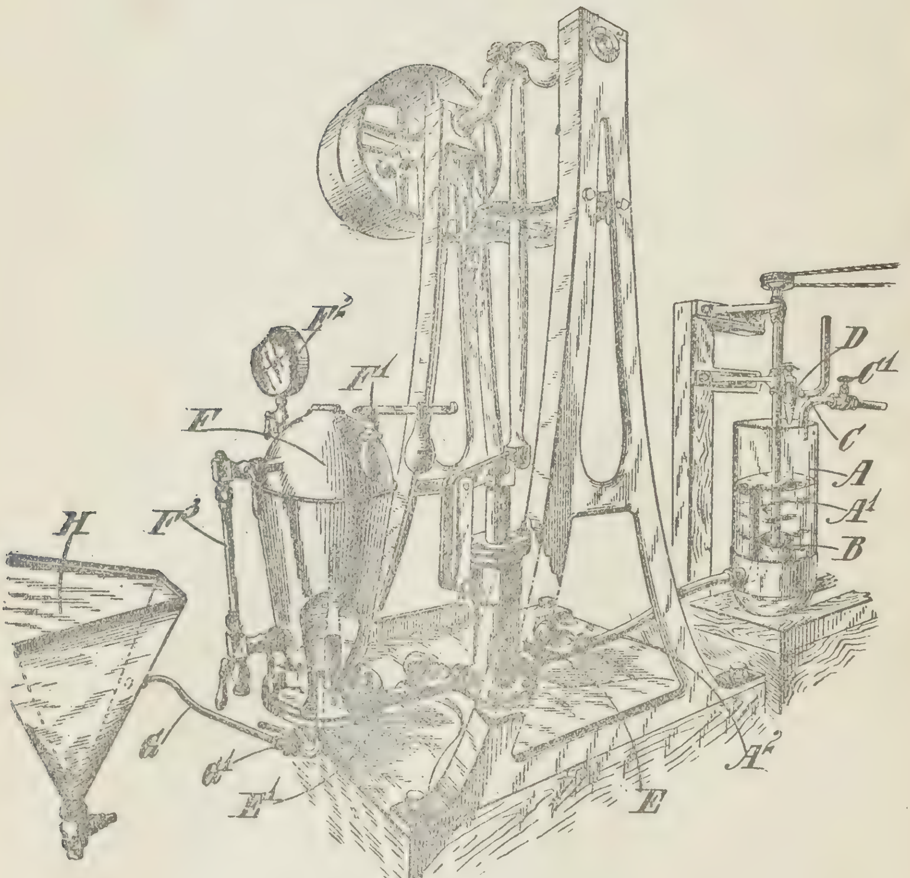
Witnesses:
R. WILLIAMS,
T. B. BUSS.

No. 835,479 PATENTED NOV. 6, 1906

H. L. SULMAN, H. F. KIRKPATRICK-PICARD & J. BALLOT.

ORE CONCENTRATION.

APPLICATION FILED JAN. 9, 1906.



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UNITED STATES PATENT OFFICE.

HENRY LIVINGSTONE SULMAN, HUGH FITZALIS KIRKPATRICK-PICARD, AND JOHN BALLOT, OF LONDON, ENGLAND, ASSIGNORS TO MINERALS SEPARATION, LIMITED, OF LONDON, ENGLAND.

ORE CONCENTRATION.

No. 835,479. Specification of Letters Patent. Patented Nov. 6, 1906.

Original application filed May 29, 1905, Serial No. 262,889. Divided and this application filed January 9, 1906. Serial No. 295,326.

To all whom it may concern:

Be it known that we, HENRY LIVINGSTONE SULMAN, HUGH FITZALIS KIRKPATRICK-PICARD, and JOHN BALLOT, subjects of the King of England, residing at London, England, have invented certain new and useful Improvements in Ore Concentration, of which the following is a specification.

This invention relates to improvements in ore concentration, and this application is a division of an application filed by us on May 29, 1905, Serial No. 262,889.

Several methods are known in which air and other gas is introduced, generated, or liberated in a pulp containing powdered ore in suspension, whereupon the gaseous films or bubbles attach themselves to certain particles, which are thereby caused to float, while other particles are not so floated.

The object of this invention is to improve such processes.

The invention is particularly applicable to the separation of oiled mineral particles from unoiled particles in a pulp; but it is also applicable in some cases in which gaseous bubbles will selectively adhere to certain particles without the use of oil.

Among the previous processes depending upon gaseous flotation is that described in our previous United States patent, No. 793,808, dated July 4, 1905, in which the flotation of oiled mineral particles is brought about by the liberation of a gas in the pulp containing them.

According to this invention it is found that a convenient method of effecting the liberation or generation of gas-bubbles in such a pulp is to subject the latter to the action of compressed air or other compressed gas in a suitable vessel or apparatus from which the pressure can be subsequently relieved. If, for example, the ore-pulp after agitation with a small proportion of oil or other suitable substance having a preferential affinity for metalliferous minerals be subjected to the action of compressed air at a pressure of, say, fifty to one hundred pounds per square inch and after the lapse of a few minutes for the due solution of the compressed air or a portion of it by the pulp or the liquid be allowed to discharge itself into an open vessel at the normal atmospheric pressure, the whole of the oiled mineral will at once rise to the surface of the pulp as a coherent scum or froth, which can be removed by skimming or by a surface current of water from the gangue, which remains sunk or suspended in the remainder of the pulp. A spitzkasten is a suitable type of vessel into which the superaerated pulp may be discharged. We have found this method very efficacious in cleaning up finely-divided ore products which have been submitted to oiling. We do not confine ourselves to the use of atmospheric air, as it is obvious that any suitable gas which is soluble in water to a sufficient extent under pressure and which preferentially attaches itself to oiled mineral particles may be employed to thus effect the gaseous flotation of the oiled mineral particles. It is to be undersood that we do not use pressures below the normal atmospheric pressure at the time being in any portion of the operation.

The accompanying drawing represents in perspective view one form of the apparatus suitable for carrying this invention into effect.

A mixing vessel A (of which there may be several in series) is provided with a rotatable stirrer B. Crushed ore or similar finely-divided mineral is fed into the vessel A. A pipe C, controlled by a tap C′, delivers circuit water to the vessel, and in cases where oil is used the oil is introduced through the pipe D in quantity sufficient to produce a thin coating of oil on these mineral particles, for which oil has an affinity.

The pulp mixed with oil escapes over the lip of a discharge-conduit A′ and passes through the pipe A^2 to a pump E. Hence the pulp is pumped through discharge-pipe E′ into the closed chamber F, which is constructed to withstand a considerable internal pressure and is provided with a safety-valve F′, the pressure-gage F^2, and a gage-glass F^3 to indicate the level of the pulp in the chamber. An outlet-pipe G, having a cock G′, leads to a series of spitzkastens H, filled with circuit-water.

The operation is as follows: The cock G′ is closed. Pulp is pumped into the chamber F, which contains air or other gas, and the pumping is continued until the pressure in the chamber rises to, say, fifty to one hundred pounds per square inch. The pressure is suf-

ficient to cause the air or other gas to be dissolved to a considerable extent in the pulp. After the lapse of a few minutes for the due solution of the compressed air or a portion of it by the pulp or the liquid the cock G′ is opened and the pulp is discharged into the open spitzkasten H, where the liquid is of course under atmospheric pressure. The pump E may be stopped during this discharge. The whole of the mineral to which air-bubbles are attached—say the oiled mineral—at once rises to the surface as a coherent scum or froth. A surface current of water is maintained in the spitzkasten, and the floating material is thus removed and separated from the gangue, which remains sunk or suspended in the liquid.

It is to be understood that the expression "oil" includes any substance, such as oleic acid, which has a preferential affinity for certain mineral substances over others.

Having thus described our invention, what we claim, and desire to secure by Letters Patent, is—

1. The process of separating powdered minerals from one another which consists in suspending the powdered minerals in a liquid, subjecting the mixture to a gas-pressure and thereafter relieving the pressure whereby bubbles of gas are liberated in the pulp and carry certain minerals to the surface.

2. The process of separating powdered minerals from one another which consists in agitating the minerals suspended in water with a small quantity of oil, subjecting the pulp to a gas-pressure and thereafter relieving the pressure whereby bubbles of gas are liberated in the pulp and carry the oiled minerals to the surface.

3. The process of separating powdered minerals from one another which consists in agitating the minerals suspended in water with a small quantity of oil, subjecting the pulp to a gas-pressure and thereafter distributing the pulp upon the surface of a column of water whereby the unoiled particles sink while the oiled particles adhering to gaseous bubbles float and are thereby separated

In testimony whereof we have signed our names to this specification in the presence of two subscribing witnesses.

HENRY LIVINGSTONE SULMAN.
HUGH FITZALIS KIRKPATRICK-PICARD.
JOHN BALLOT.

Witnesses:
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H. D. JAMESON.

No. 838,626. PATENTED DEC. 18, 1906.

E. B. KIRBY.

SEPARATING TANK.

APPLICATION FILED DEC. 17, 1903.

2 SHEETS—SHEET 1.

Fig. 1

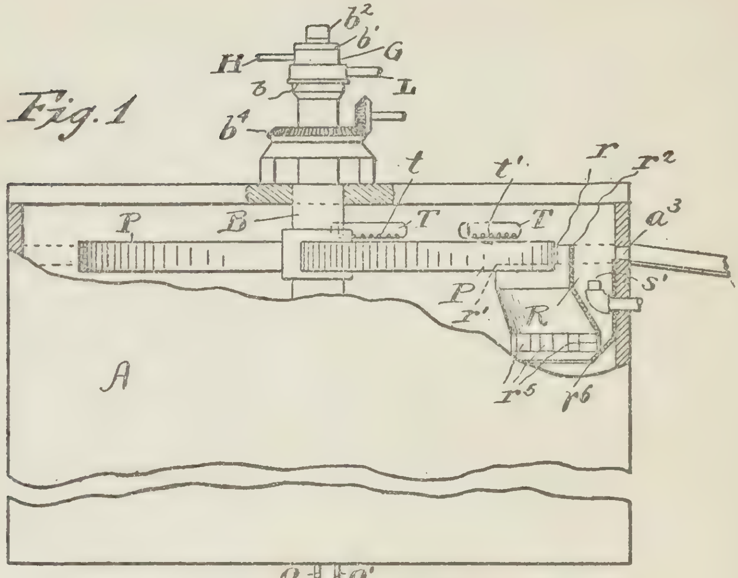
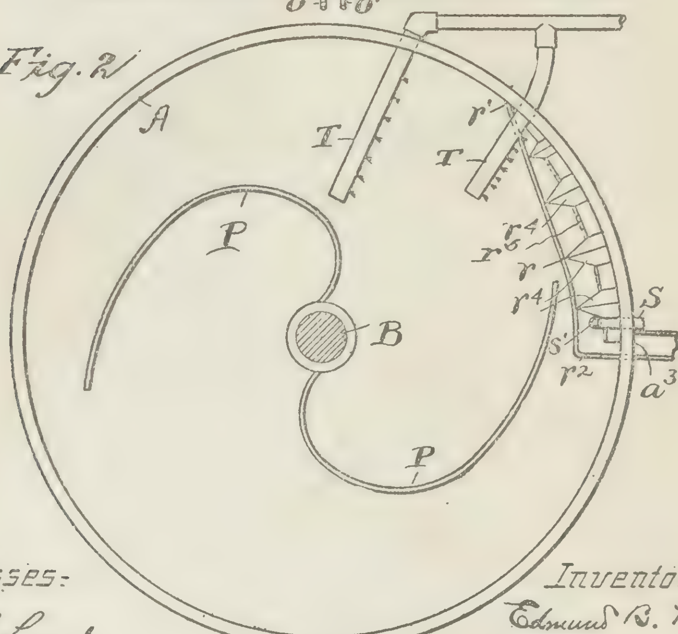


Fig. 2



Witnesses:

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No. 838,626. PATENTED DEC. 18, 1906.

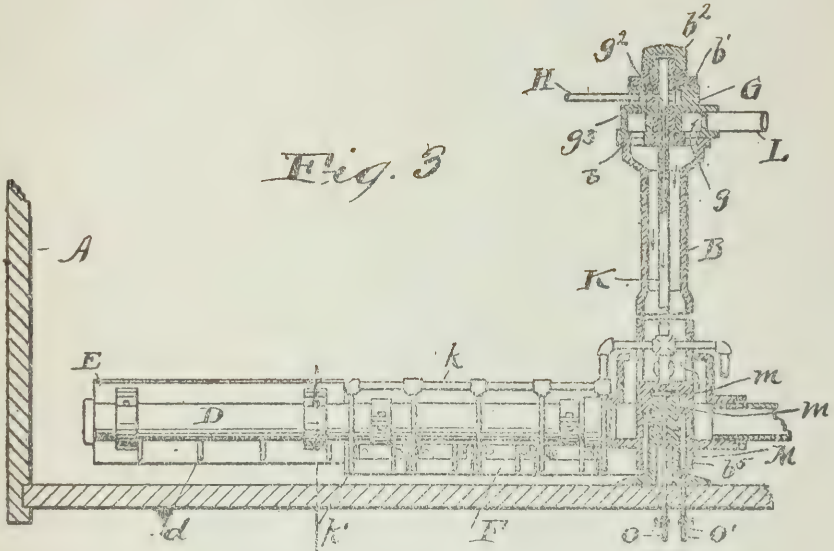
E. B. KIRBY.

SEPARATING TANK.

APPLICATION FILED DEC. 17, 1903.

2 SHEETS—SHEET 2.

Fig. 3



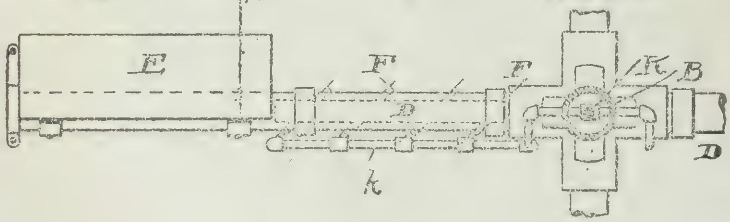


Fig. 4

Witnesses

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UNITED STATES PATENT OFFICE.

EDMUND B. KIRBY, OF ROSSLAND, BRITISH COLUMBIA, CANADA.

SEPARATING-TANK.

No. 838,626. Specification of Letters Patent. Patented Dec. 18, 1906.

Application filed December 17, 1903. Serial No 185,475.

To all whom it may concern:

Be it known that I, EDMUND B. KIRBY, a citizen of the United States, residing at Rossland, in the Province of British Columbia and Dominion of Canada, have invented a certain new and useful Improvement in Separating-Tanks, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings.

The object of this invention is to effect with substantial completeness the segregation of those pulverized mineral particles which have a preferential adhesion for water from those which have a preferential adhesion for a liquid immiscible in water—for example, oil, or a solution of bitumen in kerosene.

This invention is for the treatment of the charge after the pulverized mineral, the oil or solution, and the water have been thoroughly mixed together, whereby nearly all of the mineral particles which exhibit adhesive preference for the oil or solution have been coated therewith.

The invention is most useful when used to carry on one step of a process of my own invention, wherein the immiscible liquid employed is thin and light—as, for example, a solution of bitumen in kerosene; but the invention is also useful with oil processes for separating mineral particles.

This invention, which relates to the separator-tank and its coöperating adjuncts, may be here summarized as consisting in the construction and combinations of parts shown in the drawings and hereinafter described, as definitely set forth in the claims.

In the drawings, Figure 1 is an elevation, partly in vertical section, of an apparatus embodying my invention. Fig. 2 is a plan view thereof. Fig. 3 is a vertical sectional view of the agitator-shaft and a part of one side of the tank, and Fig. 4 is a sectional plan view of the said shaft and one of the agitator-arms secured thereto below the section-line.

The tank A is preferably cylindrical. Into it is to be charged the materials to be separated—to wit, pulverized ore, water, and some liquid lighter than water and immiscible therein, which will adhere only to the metallic mineral part of the pulverized ore—said materials having preferably been thoroughly mixed in another tank. The immiscible liquid may, as stated, be oil or a light hydrocarbon, or a solution of bitumen in a light hydrocarbon. The apparatus was especially designed for use with a charge consisting of ore, water, and solution of bitumen in kerosene, and therefore the immiscible liquid will for convenience of description be referred to herein as the "solution." The charge should be very fluid and should preferably contain three or four times as much water as mineral, some of which water may be added to the mixture after it has been transferred to the tank A.

Most of the solution and the solution-coated mineral particles rise immediately to the surface, from which they may be skimmed; but considerable quantities of the solution-coated concentrates are enveloped by and entrapped in the sands which settle to the bottom of the tank. For the primary purpose of freeing these particles from the sand and permitting them to float on the surface the vertical rotating agitator-shaft B and its adjuncts are provided. Arms D are secured to this shaft near the bottom of the tank, and as the shaft slowly rotates they gently lift the mass of sands from the bottom and overturn it and prevent it from packing, and thus permit the solution-coated particles to escape and float to the surface. These arms D are provided near their outer ends with lifting-plows E, whose front faces are set at an angle of about forty-five degrees. To these arms between the plows and the central shaft B are secured inclined scraper-blades F, which act to gradually push the material outward into the path of the plows.

It is very desirable that some gas, preferably air, shall be blown into the charge near the bottom thereof. This gas assists in agitating the charge; but its chief value is in the assistance it renders in floating the solution-coated particles to the surface. It is clear that some of these particles may be so large and heavy that the coating thereon may not be able to buoy them up, this being especially true in case the liquid used is thin and light, as the kerosene-bitumen solution. The gas-bubbles, however, not only tend to attach themselves to the solution-coated particles and to buoy them up after the fashion of balloons, but the water is caused to dissolve the gas to its maximum capacity. This dissolved gas tends to again separate from the water and attach itself in minute globules to the solution-coated particles, thus buoying them up and assisting their flotation.

It is thought that any gas which will not chemically combine with the charge may be employed in the manner and for the purpose stated; but is is definitely known that air, carbondioxid, hydrogen, and marsh-gas may be so used, air appearing to be rather the most efficient, as well as the cheapest. This gas may be injected in any way and by any means; but very efficient means for this purpose are shown in the drawings, said means consisting generally in making the shaft B and arms D hollow and providing the latter with discharge-openings and blowing the gas down through the shaft. The specific construction is as follows: The head of the shaft above the driving-gear b^4 is provided with a solution and air box G, which remains stationary while the shaft revolves and is supplied by the solution-pipe H and air-pipe L. The box rests on the rotating shoulder b of the shaft B and is held down to a tight joint by the collar b' and lock-nut cap b^2. Through the hollow shaft B extends a small solution-pipe K, the upper end of which is firmly inserted within the upward extension of the shaft and moves with and as a part of it. Air enters the annular chamber g in said box, passing through a set of apertures g' to the interior of shaft B. The solution enters a smaller annular chamber g^2, from which it passes by apertures g^3 into the top of the central pipe K. The air-current for the charge passes down through the shaft into the hollow arms D, from which it passes out through drop-pipes d. The solution is delivered from the pipe K to a series of radiating pipes k, which are secured to the arms D, and is discharged from branch pipes k'. This solution tends to attach itself to those particles not already coated, but which it will adhere to, and thus assists their flotation. The introduction of air and solution renders the separation substantially complete—that is to say, it causes substantially all of the particles which exhibit preferential adhesion for the solution to become coated thereby and floated to the surface.

The shaft B at its lower end has a stepped bearing which is supported on a pedestal M, provided with a wooden block m, which supports the moving wear-plates m' of the shaft. Lubricating-water under pressure is introduced through the pipe O and finds its way out from the bearing into the tank. The sides b^5 of the shaft are carried down below the bearing, so as to leave an annular space between them and the pedestal. This annular space is intended to constitute an air-bell designed to assist the lubricating-water in excluding sand from the bearing. The air supplied to it is maintained by a small stream of air which escapes beneath the bell through the pipe O′.

A spiral skimming-bar P, (two are shown,) which is preferably secured to the rotating shaft B, so as to extend through the floating layer of concentrates, solution, and air-bubbles, acts to direct this floating layer into the settling-chamber R and to the overflow-outlet a^3. This chamber is separated from the rest of the tank by a partition r, the upper edge of which between the points r and r' is submerged sufficiently to allow the floating layer and some of the muddy water to pass over it, while the edge of this partition between the points r and r^2 is raised above the liquid, so as to retain everything passing into it. There is an overflow-outlet a^3 from this settling-chamber through the side of the tank, which outlet is partly surrounded by the elevated part of this partition.

Owing to the agitation within the tank, caused by movement of the arms and the rising air-bubbles, the water even near the top is not clear, but turbid or muddy with slimes or fine particles of the non-coated minerals, which do not settle rapidly enough to get out of the way. The floating concentrates are carried mainly at the lower surface of the floating layer, where it is in contact with the water. The bottom of the overflow-outlet must be below the surface level of the water in order to clear them, and must therefore allow a portion of the water to pass out with the skimmings. This muddy water would therefore carry its suspended particles of the worthless minerals, which would make the concentrates impure.

The settling and washing chamber is designed to lessen or prevent this evil. As the floating material passes over its submerged edge, it escapes from the swift current and rising air-bubbles, so that in its comparative quiet the slimes have a better opportunity to settle out of the way. The box is divided into compartments by submerged partitions r^4, as shown, each compartment terminating in a hopper-shaped bottom with discharge-openings r^5, through which the settled slimes may pass out again into the tank. Projecting shields r^6 prevent the air-bubbles from entering the hoppers and disturbing their quiet.

The passage of the floating material over several of these hoppers settles most of the slime before reaching the overflow-outlet. Before reaching the outlet, however, the skimmings pass over a stream of clean wash-water introduced at the point s' through the pipe S shown. This wash-water is delivered under constant head from a supply-tank. Its quantity is made equal to that passing out through the discharge-gate with the skimmings, so that this discharge, being supplied entirely by the pure water close at hand, contains little or none of the muddy water, which is thus held back in the tank. It is evident that the incoming and outgoing streams are

self-adjusting, because if too much enters the general level rises and a large stream flows from the orifice. The flow of the floating layer over the submerged partition of the settling-chamber and on to the overflow-outlet may be induced by properly-directed air-jets blown onto said floating layer from jet-openings *t* in one or more pipes T

Having described my invention, I claim—

1. The combination of a separating-tank having an overflow-outlet, and a submerged settling-chamber in said tank discharging through said outlet, with a rotatable skimming-bar supported in said tank for directing the floating layer of concentrates into said settling-chamber and toward said overflow-outlet, substantially as specified.

2. The combination of a separating-tank containing a submerged settling-chamber at one side thereof, through whose side there is an overflow-outlet from said chamber, said chamber being formed by a partition which is partly submerged, and said chamber being divided into a plurality of hopper-shaped compartments, each having a discharge-opening through its lower end, substantially as specified.

3. The combination of a separating-tank containing a submerged settling-chamber at one side thereof, through which side there is an overflow-outlet from said chamber, said chamber being formed by a partition which is partly submerged, and said chamber being divided into a plurality of hopper-shaped compartments, each having a discharge-opening through its lower end, and a shield below each of said discharge-openings, substantially as specified.

4. The combination of a separating-tank containing a submerged settling-chamber at one side thereof, said settling-chamber having an overflow-outlet through one side of the tank, and said settling-chamber being formed by a submerged partition which projects above the surface of the fluid charge around said outlet but is at other places submerged below the floating layer on the surface of said charge, with a skimming-bar which is supported in the tank and is adapted to direct said floating layer over the submerged top of said partition into the settling-chamber and toward the overflow-outlet therefrom, substantially as specified.

5. The combination of a tank having an overflow-outlet, and a vertical rotatable shaft in said tank having agitator-arms located near the bottom of the tank, with a submerged settling-chamber in said tank discharging through said overflow-outlet, the inner partition of said chamber being extended around said outlet above the surface of the liquid charge and being submerged at other points below the floating layer of concentrates, and a spiral skimming-bar secured to the shaft so as to project through said layer whereby it directs the layer of concentrates into said settling-chamber, substantially as described.

6. A separating-tank having a submerged settling-chamber at one side, and an overflow-outlet from said chamber through said side, the inner wall of said chamber being above the surface of the fluid adjacent to said outlet, but submerged at other points below the floating layer of concentrates, and a pipe discharging clean wash-water into said settling-chamber close to said outlet, substantially as specified.

7. The combination of a separating-tank containing agitator mechanism, with means for discharging into the contained fluid charge a gas and a liquid lighter than water and immiscible therewith, substantially as specified.

8. The combination of a separating-tank, a hollow shaft rotatably mounted therein having hollow connected agitator-arms which are provided with a plurality of discharge-openings, a pipe extending through said shaft, branch pipes connected with said pipe and extending toward the sides of the tank and having downwardly-directed discharge-openings, and means for forcing gas down through said shaft, and means for forcing a liquid down through said pipe, substantially as specified.

9. The combination of a separating-tank, a rotatable agitator-shaft therein having arms secured to it near the bottom of the tank, said arms having lifting-plows near their outer ends and inclined scrapers between said plows and the shaft, substantially as described.

10. The combination of a tank, with a vertical agitator-shaft therein having a bell-shaped lower end, a pedestal which is embraced by said lower end whereby the shaft is supported, and means for discharging water into said bell-shaped shaft end, and means for discharging a gas into said bell-shaped shaft end, substantially as specified.

11. The combination of a separating-tank having an overflow-outlet, agitating mechanism, a skimming-bar, and a pipe having jet-openings arranged over the surface of the charge in the tank to move the floating surface layer toward said overflow-outlet, substantially as specified.

In testimony whereof I hereunto affix my signature in the presence of two witnesses.

EDMUND B. KIRBY.

Witnesses:

T. L. Savage,

E. G. Eastman.

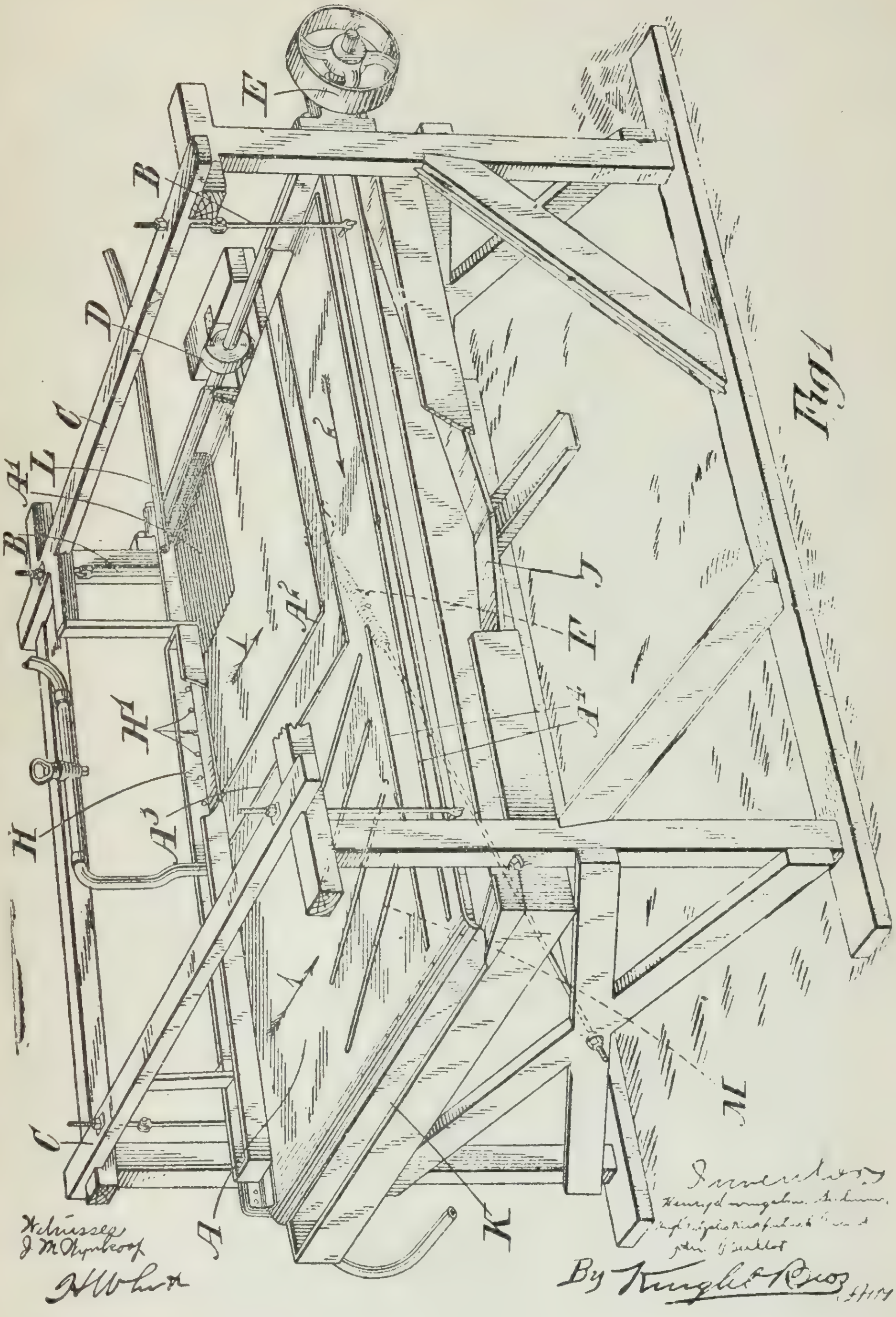
No. 879,985. PATENTED FEB. 25, 1908.

H. L. SULMAN, H. F. KIRKPATRICK-PICARD & J. BALLOT.

SEPARATION OF METALLIFEROUS MINERALS FROM GANGUE.

APPLICATION FILED FEB. 20, 1905.

4 SHEETS—SHEET 1.



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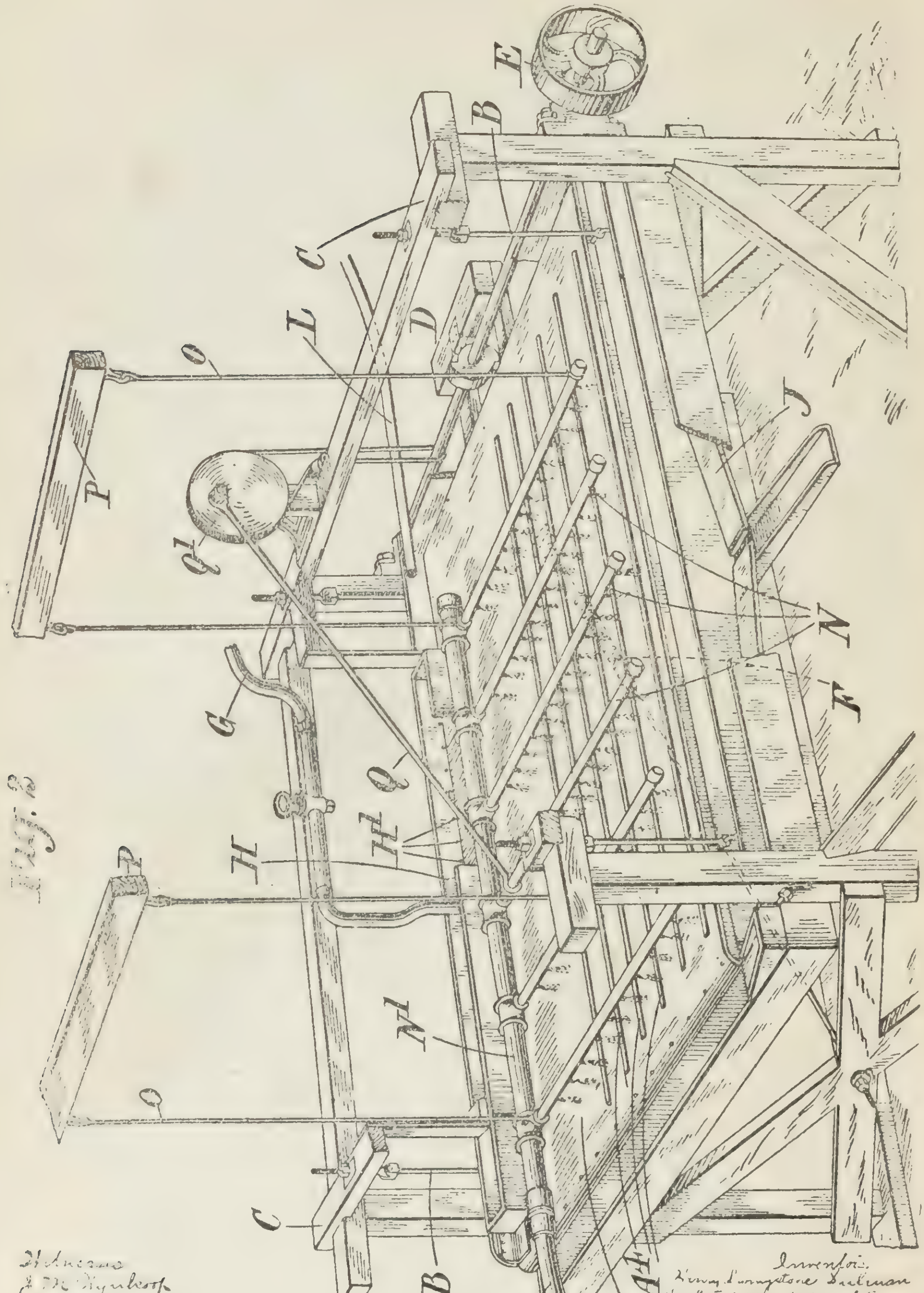
4 SHEETS—SHEET 2.



Witnesses
J. M. Wynkoop
[illegible]

Inventors
Henry Livingstone Sulman
Hugh Fitzalis Kirkpatrick Picard
John Ballot
By Knight Bros Attys

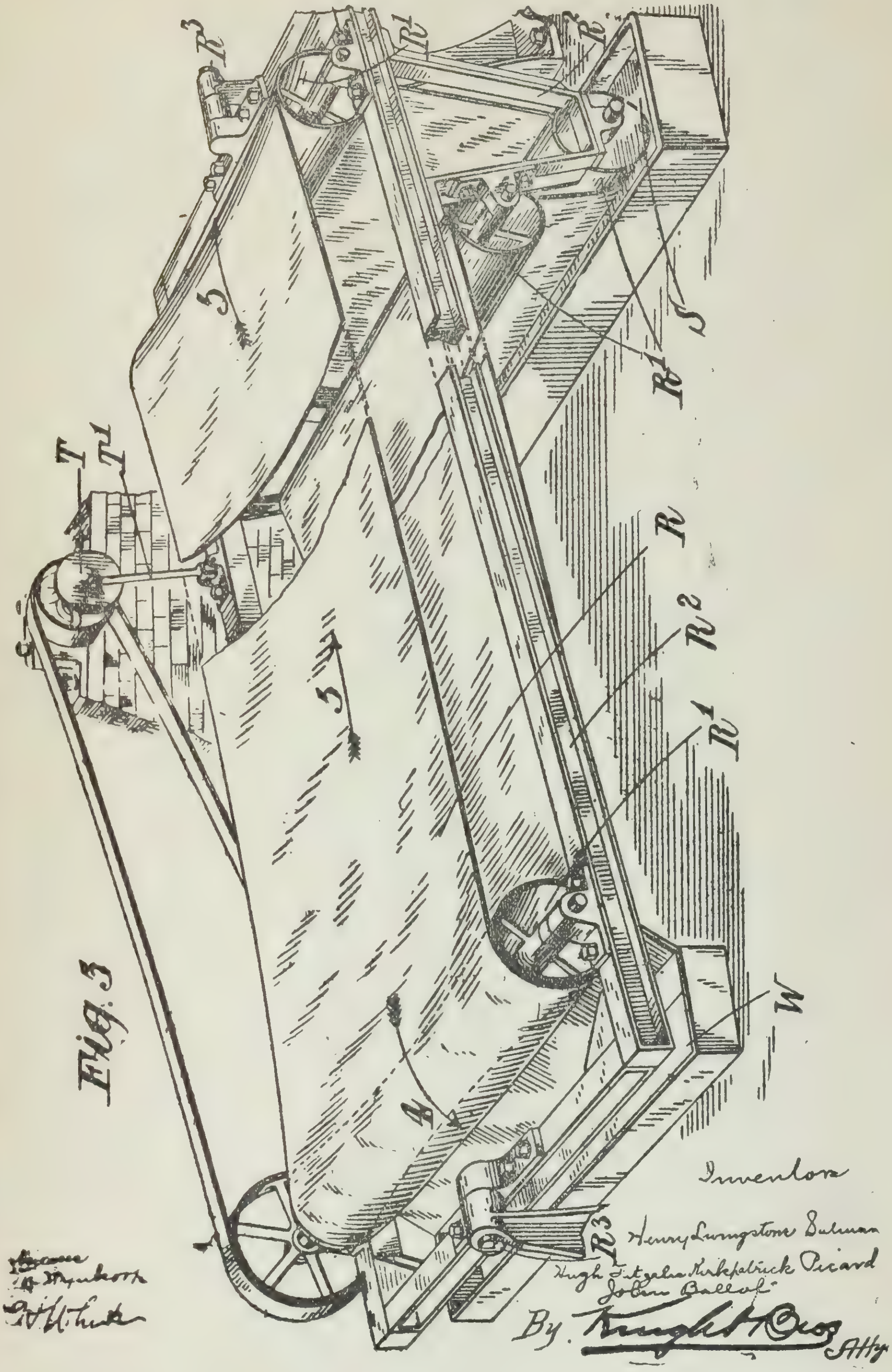
No. 879,985. PATENTED FEB. 25, 1908.

H. L. SULMAN, H. F. KIRKPATRICK-PICARD & J. BALLOT.

SEPARATION OF METALLIFEROUS MINERALS FROM GANGUE.

APPLICATION FILED FEB. 20, 1906.

4 SHEETS—SHEET 3.



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H. L. SULMAN, H. F. KIRKPATRICK-PICARD & J. BALLOT.

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4 SHEETS—SHEET 4.

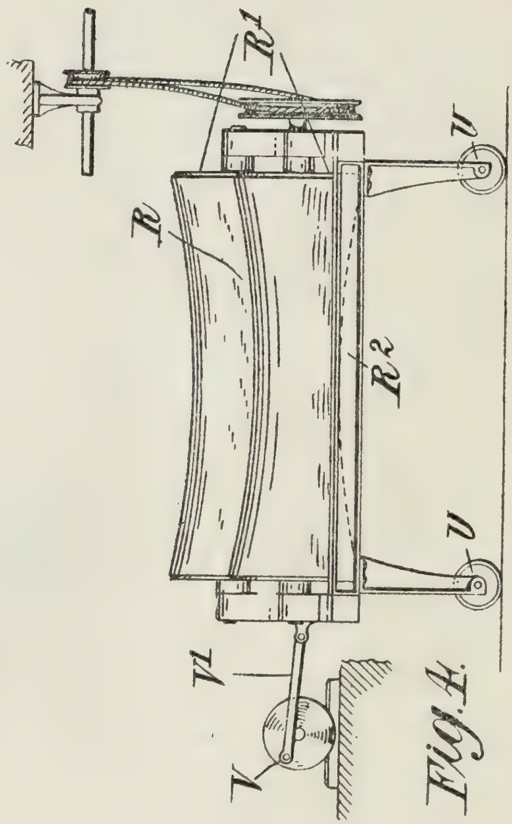

Fig. 4.

Witnesses
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H. White

Inventors.
Henry Livingstone Sulman
Hugh Fitzalis Kirkpatrick Picard
John Ballot

By Knight Bros
Atty.

UNITED STATES PATENT OFFICE.

HENRY LIVINGSTONE SULMAN, HUGH FITZALIS KIRKPATRICK-PICARD, AND JOHN BALLOT, OF LONDON, ENGLAND.

SEPARATION OF METALLIFEROUS MINERALS FROM GANGUE.

No. 879,985. **Specification of Letters Patent.** **Patented Feb. 25, 1908.**

Application filed February 20, 1905. Serial No. 246,637

To all whom it may concern:

Be it known that we, HENRY LIVINGSTONE SULMAN, HUGH FITZALIS KIRKPATRICK-PICARD, and JOHN BALLOT, subjects of the King of England, and residing in London, England, have invented certain new and useful Improvements in the Separation of Metalliferous Minerals from Gangue, of which the following is a specification.

This invention relates to improvements in the separation of metalliferous matter from gangue and has for its object to effect such separation by the agency of a substance which has a preferential affinity for metalliferous matter over gangue, and by the agency of air or other gas. The substances such as oil, fatty acid, or oleaginous, fatty or tarry substances which have a tendency to wet metalliferous matter in preference to gangue will hereinafter be referred to as "oil".

According to this invention the principles of surface-tension are applied in effecting the separation. The mineral pulp is mixed with "oil" and is exposed to a free air surface; and thereafter the mineral is brought on to the surface of water or other liquid, whereby the oiled metalliferous particles, having been exposed to air, are unable to overcome the surface tension of the water and float, while the unoiled gangue sinks through the surface of the water, the former being thus separated from the latter and removed by any suitable means.

In one particular application of this invention the pulp mixed with "oil" is distributed in the form of a thin sheet on the surface of an inclined vanning table having a transverse stream of water and currents of air are directed on to the table to expose immersed mineral to a free air surface whereupon the metalliferous matter floats and is separated from the gangue which sinks.

It is known that every free water surface, *i. e.* a water surface in contact with air or other gas, exhibits a resistance to rupture from without greater than that which is offered by its interior mass. This phenomenon is known as the surface-tension of water and permits small particles of greater specific gravity than water to float upon it without rupturing its surface. All liquids exhibit surface tension phenomena to a greater or less degree, but the results are very marked where previously oiled particles are brought upon the surface of an aqueous liquid in which the oil or other fatty substance employed is insoluble or immiscible.

The resultant of the surface-tensions between the oiled particles and air and between that of the water and air, is so increased over that which exists between the air and water and air and unoiled particles, that oily particles of a much higher specific gravity in relation to water are unable to break through the water surface and therefore float with ease, quite apart from any slight diminution to their specific weight by means of adhering oil; whereas, particles of lesser specific gravity, but unoiled, readily break through the water surface, especially if these particles be previously wetted with water.

The physical phenomena above defined are according to this invention applied as follows:—The ore in which it is desired to separate metalliferous mineral from gangue is reduced to powder of a suitable degree of fineness, and mixed with water. To the mixture, oil or fatty substance, either in a free state or as an emulsion, is added and the whole thoroughly mixed; the water may have either an acid or alkaline reaction according to the nature of the ore to be treated. Oil or fatty substance exhibits the well known tendency to adhere preferentially to metalliferous mineral immersed or suspended in water, but does not attach itself to gangue or oxids. The amount of oil used may be comparatively small in relation to the ore pulp or to the mineral present. It is not employed in quantities sufficient to buoy up, by virtue of its lesser specific gravity, the mineral particles to which it attaches itself; but it is sufficient to use only such a quantity as will insure each mineral particle being thinly coated with a film of oil or fatty substance. The mass of oiled and unoiled particles is now brought in contact with air or other gas, either by removal of the mass from the aqueous liquid or by draining off the latter; and in order to insure sufficient air contact, the mass should be exposed in comparatively thin layers or sheets. If the particles be now brought upon or into contact with a fresh water surface, the previously specified surface-tension factors are brought into play, and it will be found that the oiled metalliferous particles can be floated off with ease and

completeness from the gangue or unoiled particles, the latter sinking through the water surface.

In the accompanying drawings:—Figures 1, 2 and 3 are perspective views of three different forms of apparatus suitable for carrying this Invention into practical effect; and Fig. 4 is an end elevation of a modification of Fig. 3.

Referring to Fig. 1, an inclined vanning table A is supported by hangers B from a fixed framework C. An endwise jerking motion is imparted to the table in the direction of the arrows 2 by a cam D rotated by a driven pulley E, and a strong spring F acts in the opposite direction to the cam. A stream of water from a pipe G is distributed from a channel H perforated as at H^1 so as to flow across the table in the direction of the arrows 1. At the discharge side of the table is one launder J while a second launder K at the end of the table receives the longitudinal discharge. The mineral may be oiled in the manner before indicated or according to any of the known means, and the pulp mass is fed through a pipe L and through a suitable distributer, if required, on to the surface of the table A. Directly the oiled particles, having come into contact with air arrive on the water surface, they float for a sufficiently long period in the direction of the arrows 1 and thus permit of their separation and recovery in the launder or receptacle J; while the gangue sinks through the film of aqueous liquid and in consequence of the vanning motion imparted to the table works forward in the direction of the arrows 2 and is collected in the launder or receptacle K. In order to expose the pulp to the air as much as possible the surface of the table may be corrugated as at A^1 or a series of steps such as A^2 A^3 may be formed thereon. Or a series of raised surfaces M placed at a suitable angle to the forward travel of the submerged particles may be formed on the surface of the table, over which the submerged particles are forced to climb by virtue of the forward jerking motion, and by these means any oiled particle which may have escaped air contact is caused to come into such contact. If required guiding ribs A^4 may be attached, to direct the gangue to the launder K.

Referring now to Fig. 2, the vanning table is arranged as described with reference to Fig. 1 without the parts A^1, A^2, A^3, but if desired with longitudinal ribs A^4. Above the table is arranged a series of pipes N perforated on the under side, supported by wires or ties O from a framework P or the like. To the pipes N is attached a connecting rod Q reciprocated by a crank Q^1 so that the pipes are moved to and fro above the surface of the table. Air is led into the pipes N through an inlet tube N^1. Should any oiled mineral penetrate the water surface, it will be brought into contact with air again by the air jets blowing on the surface so as to rupture it and expose the immersed oiled particles to the air.

Referring to Fig. 3, the continuous inclined concave belt R passing over the rollers R^1 is driven upwards on the top side in the direction of the arrows 3; then it passes down through a trough S containing water. The rollers R^1 are carried in a frame R^2 pivoted at R^3 about the longitudinal axis and the frame is rocked about its piovts by a crank T and connecting rod T^1. Or, as shown in Fig. 4 the frame may be mounted on rollers U and lateral reciprocating motion imparted to the frame by a crank V and connecting rod V^1. The pulp is fed on to the top of the moving belt and a certain proportion of oiled mineral floats, and is carried downward by the stream into the launder W in the direction of the arrow 4; while the unoiled particles sink and are carried up by the belt in the direction of the arrows 3, and discharged into the trough S. As the belt rocks or reciprocates, the liquid moves from side to side, and at each movement leaves some mineral freely exposed to the air on the side of the belt. Thus, any immersed oiled particles become exposed to a free air surface and on the return of the liquid are floated off and carried down into the launder W. The inclination of the belt must be so regulated that no sands are mechanically carried off with the concentrates.

Any apparatus suitable for the separation of floating from immersed solid particles may be used to effect the separation according to this invention. The water used to form the water surface may conveniently be slightly acid or in certain cases slightly alkaline, provided that the alkalinity is not sufficient to affect the surface-tension.

The flotation power exerted in the method above described is so considerable that aggregations of heavy oiled mineral particles may be observed floating upon the surface of the water, (more or less self-adherent) and exhibiting a concave or boat-like formation upon the surface of the water, due to the great specific gravity of the mineral particles which in consequence of their oiled surfaces are yet unable to break through the water surface.

We are aware that gases have been used previously for the separation of oiled mineral particles from unoiled particles when immersed beneath the surface of an aqueous liquid. This has been effected by the attachment of gas bubbles (preferably generated in the liquid *i. e.* in an acid condition) whereby the mineral particles are raised to the surface by means of the buoyancy of the gas bubbles adhering to the particles. It is to be clearly understood that our method of separation does not take place beneath the

water surface but depends solely on the flotation of previously oiled particles which have been brought into contact with air or other gas and then introduced upon the water surface.

What we claim as our invention and desire to secure by Letters Patent is:—

1. The process of treating ores to separate metalliferous matter from gangue which consists in mixing the powdered mineral with water to form a freely flowing pulp, agitating the mineral pulp with a small quantity of oil sufficient only to impart a thin coating of oil to the metalliferous particles, distributing the mixture in the form of a thin sheet of flowing liquid, causing the immersed particles to be exposed to the air and thereafter to meet the surface of the liquid, collecting the floating oiled metalliferous particles and collecting the gangue which sinks.

2. The process of treating ores to separate metalliferous matter from gangue which consists in mixing the powdered mineral with water to form a freely flowing pulp, agitating the mineral pulp with a small quantity of oil sufficient only to impart a thin coating of oil to the metalliferous particles distributing the mixture in the form of a thin sheet of flowing liquid, directing currents of air on to the liquid to expose the immersed mineral to the air, whereby the oil-coated metalliferous particles float, collecting the floating oiled metalliferous particles and collecting the gangue which sinks.

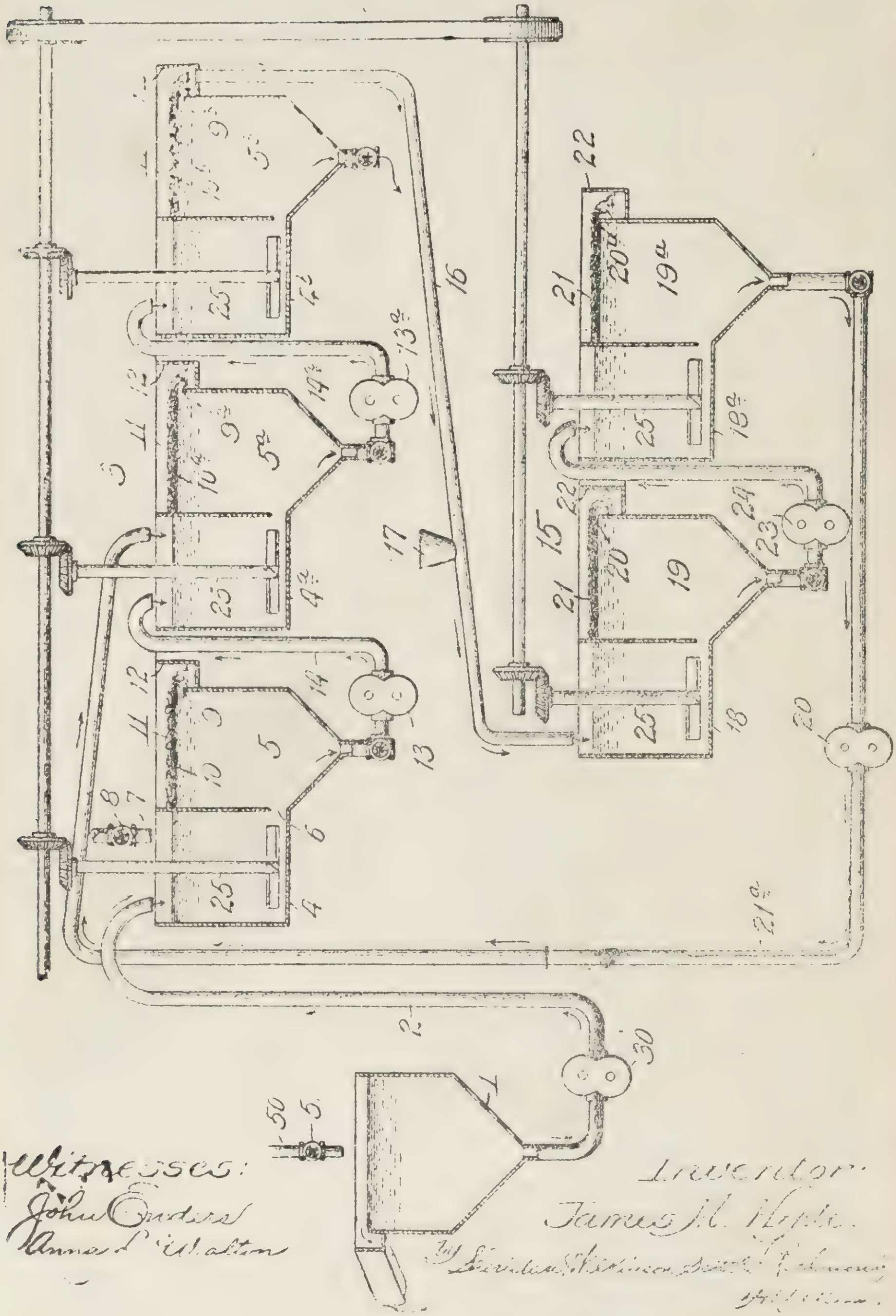
In testimony whereof we have signed our names to this specification in the presence of two subscribing witnesses.

HENRY LIVINGSTONE SULMAN.
HUGH FITZALIS KIRKPATRICK-PICARD.
JOHN BALLOT.

Witnesses:
WILLIAM H. BALLANTYNE,
W. W. WEBSTER.

J. M. HYDE.
ART OF CONCENTRATION OF MINERAL SUBSTANCES.
APPLICATION FILED NOV. 10, 1911.

1,022,085. Patented Apr. 2, 1912.



Witnesses:
John Enders
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Inventor:
James M. Hyde.
By ... Attorneys.

UNITED STATES PATENT OFFICE.

JAMES M. HYDE, OF BASIN, MONTANA.

ART OF CONCENTRATION OF MINERAL SUBSTANCES.

1,022,085. Specification of Letters Patent. Patented Apr. 2, 1912.

Application filed November 10, 1911. Serial No. 659,583.

To all whom it may concern:

Be it known that I, JAMES M. HYDE, a citizen of the United States, residing at Basin, in the county of Jefferson and State of Montana, have invented certain new and useful Improvements in the Art of Concentration of Mineral Substances, of which the following is a specification.

My invention relates to the separation by a flotation process of a part of the mineral substances composing an ore consisting of a plurality of mineral components.

It has heretofore been demonstrated that certain metallic and non-metallic elements, and certain natural chemical compounds of the metallic elements differ from the ordinary less valuable or valueless gangue minerals with which they occur in ore deposits, in that under certain conditions they are preferentially coated by oils, fats, oleaginous and fatty substances and derivatives thereof, and certain other organic compounds, and that when so coated they exhibit markedly different surface tension phenomena from, and can by various devices and methods be separated from, the gangue minerals, and, in certain instances at least, to a certain extent from one another.

Many ores containing a plurality of mineral components are of such a nature that when they are crushed a considerable amount of the resultant pulverized material consists of particles which are so fine and of such a colloidal nature that they settle very slowly and interfere with obtaining a high grade concentrate by the use of a flotation process. In the treatment of ores of this class I have found that their treatment is greatly facilitated, and a considerable economy is effected, by introducing a small amount of sulfuric acid with or without copperas, alum or some other such coagulant, into the pulp while in transit to the flotation device, instead of by using a larger amount of acid in the flotation device as has been done in previous practice. The acid apparently performs the following, among other functions:—the partial or complete coagulation of the slimes so that they settle much more quickly, thus making possible the thickening of the pulp in an intermittent or continuously acting pulp thickener, by the removal of a considerable amount of clear water or water containing a lessened amount of suspended solid matter, and also greatly facilitating the separation of the concentrates from the gangue in the flotation machine; the cleaning of the surface of the particles of the floatable minerals, so that they may be more readily coated by the chosen coating reagent; the generation of minute bubbles of gas in the pulp and on the surface of the floatable mineral particles, which bubbles assist in the desired separation of the mineral components of the ore; and in neutralizing any alkalinity of the ore or treatment water. The addition of the acid to the pulp before it reaches the flotation machine, rather than in the machine as has heretofore been done, affords a longer period of contact with the ore and greatly reduces the amount of acid which it is necessary to use. It precludes the necessity of having the pulp show any free acid when the flotation treatment takes place. By following this method, I have been able to get highly satisfactory results when using as little as one quarter of a pound of crude acid per ton of ore treated, whereas in previously used methods, several pounds have been found necessary.

I have further discovered that the concentrates produced, when the acid is used substantially as hereinbefore described may be retreated and raised in grade, when they contain free particles of the gangue matter, by being put through a treatment similar to that by which they were made, and that this retreatment can, in certain cases at least, be satisfactorily made without the use of additional amount of acid or coating reagent in the "cleaner machine."

Any fats or oils, fatty or oleaginous substances or derivatives thereof, and any other organic compounds which preferentially coat mineral substances may be used in this process for the coating of such mineral particles as can be made to float on the surface of water for any of the following reasons:—because of the lower specific gravity of the oily or fatty substances to which they are attached, because of their tendency to form a film on the surface of the water when properly coated, or because of their tendency to attach themselves to and be raised by bubbles of any gas which may be generated in, or introduced into the pulp.

A suitable apparatus for carrying out this process consists of launders or pipes, used in connection with or without pulp thick-

eners, and a combination of mixing boxes and spitzkastens, or overflow separating devices. Any one of a number of devices now in use, or any simple and apparent modification thereof may be made use of for this purpose.

In the drawing I have diagrammatically illustrated an apparatus whereby my process can be conveniently practiced.

Acid is added to the pulp in or prior to reaching the pulp thickener 1, which is used if the prior treatment of the ore has given rise to a pulp containing more water than is suitable for the practice of my process. The acid whether added to the pulp in the thickener or before reaching the thickener is supplied through means under the control of the operator, such as the pipe 50 leading from the acid supply, which pipe is provided with a hand valve 51. The pulp thickener may consist of any of the ordinary devices used for that purpose, such as pointed boxes having provision for overflow of the clear water. The thickened pulp is drawn off from the bottom of the thickener 1 and the waste water allowed to flow from the top thereof. The thickened pulp is conducted from the thickener 1 through the pipe or launder 2 to the flotation machine designated generally by the numeral 3, a pump 30 being used for this purpose, if necessary. The flotation machine as illustrated consists of three agitator tanks 4, 4^a and 4^b, and three settlement boxes 5, 5^a and 5^b. Each of the agitator tanks may, if necessary, consist of a plurality of connected compartments each provided with an agitator. The agitator tank 4 is connected near its lower end at 6 with the settlement box 5, the agitator tank 4 and settlement box 5 constituting the first unit of the flotation or separation apparatus. The other two units consist respectively of the agitator tank 4^a with its settlement box 5^a and the agitator tank 4^b with its settlement box 5^b. The three units are of similar construction. The pulp is first received in the agitator tank 4 and thoroughly agitated with oil from the pipe 7, which is provided with a hand valve 8 under the control of the operator. The pulp flows continuously through the machine, its rate of flow being regulated in such manner as to produce the best results. After agitation in the tank 4 the pulp passes through the passage 6 into the settlement tank 5. The sulfid particles having become coated with oil in the agitator tank 4 rise to the surface of the settlement tank 5 in the form of a froth or scum. The level of the pulp in the apparatus is so regulated by means of suitable valves that at the overflow lips 9, 9^a and 9^b of the settlement boxes 5, 5^a and 5^b the lower surface 10 of the froth 11 is sufficiently above the lip to insure the overflow of all of the froth 11 into the launder 12. This arrangement permits more or less water to pass over with the froth into the launder 12. The partially treated pulp, still containing more or less of the sulfids or other ore values, is drawn off from the bottom of the settlement box 5 and by means of a pump 13 is forced through the pipe 14 and discharged into the agitator tank 4^a of the second unit of the flotation machine. The apparatus is preferably so arranged that the pulp stands at the same level in the different units of the flotation device, and in the second unit of the cleaner machine which is described below, in which event the pumps are not necessary to lift the pulp but merely serve to assist in its movement. The arrangement of the apparatus may, however, be varied when necessary or desirable. In this unit the same operation takes place as in the first unit, namely, agitation in the tank 4^a, overflow of froth with more or less water from the settlement box 5^a into the launder 12 and discharge of the pulp from the bottom of the settlement box 5^a. From the bottom of the settlement box 5^a the pulp is forced by means of a pump 13^a through pipe 14^a and discharged into the agitator tank 4^b of the third unit where the pulp is agitated and discharged into the settlement box 5^b where the froth with some water is drawn off into the launder 12. The pulp after treatment in the third unit is discharged from the bottom of the settlement box 5^b as tailings or waste, the treatment above described in the three units of the flotation machine having practically exhausted the ore of its valuable parts. In practice I have attained by the treatment described a separation running as high as 95% of the sulfids.

In conducting my process the operator constantly observes the condition of the material in the agitator tanks and on the surface of the settlement boxes 5, 5^a and 5^b of the flotation machine, and likewise observes the condition of the tailings being discharged from the machine. By such observation the operator is enabled to determine whether the sulfids or other ore values are being properly separated from the gangue. The appearance of flocculent masses of sulfids in the tailings indicates the use of too large an amount of oil, while the appearance of finely divided sulfids in the tailings indicates the use of too little oil. Other indications are apparent to an operator after a little experience and by properly manipulating the valve 8 which regulates the oil supply he is able to control the operation in such manner as to secure a maximum recovery, equal, as above stated, in some cases to 95% of the entire value contained in the ore.

The launder or pipe 12 receives the sulfids, together with some water and gangue from all three units of the flotation ma-

chine 3 and these sulfids are conducted from the launder 12 to the cleaner machine which is designated generally by the numeral 15. In transit from the flotation machine to the cleaner machine the froth is conducted through a launder or pipe 16 and more water is supplied thereto, if necessary, through a pipe 17. The concentrates thus diluted are discharged into the agitator tank 18 of the cleaning apparatus and are there agitated with or without the addition of further oil, acid or other chemicals as may be desirable. From the agitator box 18 the concentrates with the water carrying them are conducted to the settlement box 19. The froth obtained in the primary or flotation machine 3 contains more or less gangue which is entrapped in the froth, and it is to purify the concentrates that I employ the secondary or cleaner machine 15. The agitation of the concentrates in the secondary machine has the effect of breaking them up to a considerable extent thereby causing the entrapped gangue to become separated from the oil coated concentrates. After agitation of the concentrates in the tank 18, as above stated, the concentrates, together with the water added thereto, are conducted to the settlement box 19, in which the gangue which has been freed from the concentrates settles to the bottom with a certain amount of the sulfids. The level of the material in the cleaning machine 15 is so regulated by means of suitable valves that the overflow lips 20 and 20ª of the settlement boxes 19 and 19ª extend slightly above the lower surface of the froth 21, the purpose being to prevent any escape of free flowing water with the froth 21 into the launder 22. As a result of this arrangement some of the froth and all of the slime carrying water will be prevented from overflowing into the launder 22 and will be carried down to the bottom of the settlement box 19. From the bottom of the settlement box 19 the water carrying with it such gangue as has been freed from the froth and also carrying such of the sulfids as have failed to flow over the lip 20 is forced by the pump 23 through the pipe 24 and discharged into the second agitator tank 18ª of the cleaning machine. The operation in the second unit of the cleaning machine is precisely the same as that described in the first unit, the overflow at the lip 20ª being adjusted as described in connection with the first unit to prevent foul water from overflowing into the launder 22. The discharge from the bottom of the settlement box 19ª will therefore contain not only such of the gangue as has been freed from the oil-coated sulfids, but will also contain a small amount of the sulfids. The discharge from the bottom of the second settlement box 19ª of the cleaner machine is therefore forced by a pump 20 or otherwise conducted through pipe 21ª and discharged into the agitator tank 4 or 4ª of the flotation machine and carried through the rest of the apparatus, together with the fresh pulp.

By the means above described, I remove a large portion of the impurities from the concentrates formed in the flotation machine, and by conducting the material drawn off from the bottom of the settlement tank 19ª of the cleaner machine and retreating the same in the primary or flotation machine I effectually guard against any loss of concentrates in the cleaning operation. The agitators 25 shown in the agitator tanks of the flotation and cleaning machines may be of any preferred form and rotated by any means available.

As an example of the way in which these improvements may be used the following description is given of the treatment of a parcel of ore by this method. The material treated was the slimy portion of an ore consisting principally of quartz, blende (the sulfid of zinc) and varying amounts of decomposed granite in which the feldspars were largely kaolinized. About 92% of this material was fine enough to pass through a 150 mesh screen. Unless a coagulant were used a portion of the slime containing a valuable amount of zinc would remain in suspension for over 24 hours. The pulp as produced contained from 20 to 100 or more parts of water by weight to one part of ore, whereas the ratio should have been from two and one half to one to four to one. To this pulp while in transit to the thickeners, was added an amount of commercial sulfuric acid equivalent to from one quarter to one half pound per ton of ore treated. At times a decided odor of hydrogen sulfid could be noticed around the pulp thickeners. The thickened pulp, usually showing no free acidity, was led to the flotation machine in which it was heated by live steam to enlarge and expand the gas bubbles generated by the acid and to facilitate the coating of the sulfid particles with the coating reagent which was added in the flotation machine. The amount of oil necessary to produce the proper result cannot be determined in advance owing to variations in the rate of flow of pulp through the apparatus, differences in the degree of dilution of the pulp, *i. e.* differences in the amount of ore carried by the water, and variations in the composition of the ore, the ore sometimes running much higher in sulfids than at other times. There may also be other factors which have an effect upon the quantity of oil necessary to float the maximum percentage of the sulfids or other ore values. At any rate, I have found in practice that the only efficient mode of carrying out the process is to constantly observe the results produced and to vary the

supply of oil accordingly. The flotation or separation machine used in the test was of a character similar to that illustrated and described above. The pulp was thoroughly agitated to insure the coating of all of the sulfid particles with the proportionately very small amount of "candle maker's red oil" which was used as the coating agent.

After treatment in the three units of the separation machine the gangue matter as tailings was run to waste from the bottom of the settlement box of the third unit. The concentrates which had overflowed from the three settlement boxes of the primary machine were collected in the same launder and conducted to the secondary or cleaner machine, and in the cleaner machine the concentrates were treated without further addition of oil or acid. From the cleaner machine high grade concentrates were collected and rich tailings were returned to the second unit of the primary machine for retreatment. In this test run the ore fed contained 23.3% zinc, the concentrates 51.4% zinc, and the tailings 3.2% zinc, giving an indicated recovery of 91% of the zinc in the ore treated. These results were in large part due to the method of using the acid and retreating the concentrates made in the primary machine, which concentrates contained but from 38% to 42% of zinc before retreatment.

It will be understood that the apparatus diagrammatically illustrated in the drawing may be varied in form, the illustration and description of the apparatus referred to being introduced merely for the purpose of clearly setting forth the several steps of my process.

I claim:

1. The process of concentrating ore pulps comprising a separation treatment which consists in adding to the pulp a material which preferentially coats the valuable particles of the ore, agitating the mixture, permitting the valuable parts of the ore to float in the form of a froth, separating the froth by overflowing it together with some of the water in order to insure overflow of the entire mass of the froth, subjecting the separated froth to a cleaning treatment which consists in reagitating the concentrated material to free impurities entrapped therewith, permitting the concentrates to again form a froth and allowing the impurities to settle, overflowing the froth without any free flowing water, and returning the settled impurities and the part of the froth not carried into the overflow to the part of the pulp which is undergoing the separation treatment.

2. A continuous process of concentrating the valuable constituents from ore pulps comprising the addition to the pulp of an acid precipitant adapted to react upon the ore, allowing a time interval to elapse prior to subjecting it to the separation treatment, then subjecting the pulp to a separation treatment comprising the steps of adding a material which will preferentially coat the valuable particles of the ore and separating said coated particles as a concentrate by flotation.

3. A continuous process of concentrating the valuable constitutents from ore pulps comprising the addition to the pulp of an acid precipitant adapted to react upon the ore, allowing a time interval to elapse prior to subjecting it to the separation treatment then subjecting the pulp to a separation treatment comprising the steps of adding a non-metallic material which will preferentially coat the valuable particles of the ore and separating said coated particles as a concentrate.

4. A continuous process of concentrating the valuable constituents from ore pulps comprising the addition of an acid precipitant to the pulp, allowing a time interval to elapse prior to subjecting it to the separation treatment, then subjecting the pulp to a separation treatment comprising the steps of adding a material which will preferentially coat the valuable particles of the ore and separating said coated particles as a concentrate by flotation, subjecting the concentrate thus produced to a cleaning treatment which consists in agitating the concentrated material, permitting the concentrates to float, removing the concentrates from the top of the mixture, and returning the material which settles after the cleaning agitation to the part of the pulp which has passed through the first two steps specified and which is undergoing the separation treatment.

5. A continuous process of concentrating the valuable constituents from ore pulps comprising the addition of an acid precipitant to the pulp, allowing a time interval to elapse prior to subjecting it to the separation treatment, then subjecting the pulp to a separation treatment comprising the steps of adding a material which will preferentially coat the valuable particles of the ore and separating said coated particles as a concentrate, subjecting the concentrate thus produced to a cleaning treatment which consists in agitating the concentrated material, removing the concentrates from the mixture, and returning the rest of the mixture to the part of the pulp which has passed through the first two steps specified and which is undergoing the separation treatment.

6. A continuous process of thickening and concentrating ore pulps comprising the addition to the thin pulp of an acid precipitant adapted to react upon the ore and producing a thickened pulp by separating water, then subjecting the thickened pulp to a separation treatment comprising the steps of adding a

material which will preferentially coat the valuable particles of the ore, and separating said coated particles as a concentrate by flotation.

7. A continuous process of thickening and concentrating ore pulps comprising the addition of an acid precipitant to the thin pulp, producing a thickened pulp by separating water, then subjecting the thickened pulp to a separation treatment comprising the steps of adding a material which will preferentially coat the valuable particles of the ore, and separating said coated particles as a concentrate by flotation, subjecting the concentrates thus produced to a cleaning treatment which consists in agitating the concentrated material, permitting the concentrates to float, removing the concentrates from the top of the mixture, and returning the material which settles after the cleaning agitation to the part of the pulp which is undergoing the separation treatment after the thickening step.

8. The process of concentrating ore pulps comprising a separation treatment which consists in adding to the pulp a material which preferentially coats the valuable particles of the ore, agitating the mixture, permitting the valuable particles of ore to float in the form of a froth, separating the froth with some of the water in order to insure separation of the entire mass of the froth, subjecting the separated froth to a cleaning treatment which consists in reagitating the concentrated material to free impurities entrapped therewith, permitting the concentrates to again form a froth and allowing the impurities to settle, removing the froth without water, and returning the settled impurities and the part of the froth not removed to the part of the pulp which is undergoing the separation treatment.

9. The process of concentrating ore pulps comprising a separation treatment which consists in adding to the pulp a material which preferentially coats the valuable particles of the ore, agitating the mixture to bring the coating material into contact with all of the particles which can be made to float, separating the floating coated material as a concentrate with some of the water thereby insuring removal of all of the floating material, subjecting this separated material to a cleaning treatment to permit the impurities remaining therewith to settle and refloating the concentrates, removing the upper purest part of the cleaned concentrates and returning the impurities and the remaining part of the concentrates to the part of the pulp which is undergoing the initial flotation treatment prior to the cleaning operation.

10. The process of concentrating ores which consists in adding to the ore a material which preferentially coats the valuable particles of the ore, separating said coated valuable particles from the gangue by floating said coated valuable particles on water, separating the floating coated particles as a concentrate with some of the water thereby insuring removal of all of the floating valuable particles, subjecting this separated material to a cleaning treatment to permit the impurities remaining therewith to settle and refloating the concentrates, removing the upper purest part of the cleaned concentrates, and returning the impurities and the remaining part of the concentrates to the part of the ore which is undergoing the initial flotation treatment prior to the cleaning operation.

In testimony whereof, I have subscribed my name.

JAMES M. HYDE.

Witnesses:
J. BRUCE KREMER,
WALTER A. SCOTT.

N° 12,778 A.D. 1902

Date of Application, 4th June, 1902
Complete Specification Left, 4th Mar., 1903—Accepted, 4th June, 1903

PROVISIONAL SPECIFICATION.

Communicated by ALCIDE FROMENT of Traversella, in the Kingdom of Italy, Engineer.

"Improvements relating to the Concentration of Ores"

I, HENRY HARRIS LAKE, of the Firm of Haseltine, Lake & Co., Patent Agents, 45, Southampton Buildings, in the County of Middlesex, do hereby declare the nature of this invention to be as follows:—

The following phenomena, studied by the inventor, have served as the basis of the process which forms the subject of this invention.

1. When the natural sulphides reduced to powder are moistened by a fatty substance, they have a tendency to unite in spherules and to float upon the surface of water.

2. This tendency is simply retarded by the specific weight, and opposed by the gangue which imprisons the moistened sulphides in its pulverulent mass.

3. If a gas of any kind is liberated in this mass, the bubbles of the gas become covered with an envelope of sulphides and thus rise readily to the surface of the liquid where they form a kind of metallic magma.

3. The formation of these metallic spherules is singularly active if the gas is in a nascent state.

Thus for example, if in a test tube there is placed say ten grammes of sulphuretted copper ore with its gangue, a gram of limestone, the whole reduced to powder, and if there is added thereto thirty grammes of water, a few drops of sulphuric acid and a thin layer of ordinary oil, and the mixture then agitated for a brief space, the whole of the chalcopyrite will instantly rise to the top of the liquid. The metallic spherules, pressed one against the other, will become grouped in a magma clearly separated from the rest of the liquid. If the limestone is in excess or readily attackable, the rapidity of the separation is so great that the chalcopyrite is forcibly projected outside the vessel. There is therefore a proportion to be sought for a given ore and limestone.

The small quantity of gangue mechanically conveyed gradually falls and the sulphides remain in a state of almost complete purity. Such is the principle.

Thus, the rapidity of the formation of the spherules and their ascension is in direct ratio to the quantity of gas produced in a given time.

EXAMPLE 1

A cuprous ore containing 12% of chalcopyrite, 15% of iron pyrite, 20% of carbonate of iron, 16% of dolomite and calcite and 37% of various gangues have been submitted to my said process. It should be stated that this ore could not be enriched economically by any known means.

Only a few seconds were necessary for completely separating the sulphide of copper from the rest of the gangue in which no single trace of copper could be discovered by analysis.

EXAMPLE 2.

A calcitous ore having ·10% of lead and unmarketable with such a proportion,

[*Price 8d.*]

has been treated in the same manner and with the same success. There are several operations which are distinct but which are connected in carrying the process into practice; the formation of the spherules and their separation from the gangue, then separation of the product of the concentration from the oil and recovery of this latter for readmission to the cycle of operations. The products of the concentration form cakes.

Dated this 4th day of June 1902.

HASELTINE LAKE & Co
45 Southampton Buildings, London, W.C.
Agents for the Applicant.

COMPLETE SPECIFICATION.

"Improvements relating to the Concentration of Ores"

I, Henry Harris Lake, of the Firm of Haseltine, Lake & Co., Patent Agents, 45, Southampton Buildings, in the County of Middlesex, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention has reference to the concentration of metalliferous ores and earths for the purpose of separating and recovering therefrom the finely divided metal or metallic compounds, and consists of a modification of what is known as the oil process of ore concentration.

The following phenomena, studied by the inventor, have served as the basis of the process which forms the subject of this invention.

1. When the natural sulphides reduced to powder are moistened by a fatty substance, they have a tendency to unite in spherules and to float upon the surface of water.

2. This tendency is simply retarded by the specific weight and opposed by the gangue which imprisons the moistened sulphides in its pulverulent mass.

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Example 1.

A cuprous ore containing 12% of copperpyrite, 15% of iron pyrite, 20% of

carbonate of iron, 16% of dolomite and calcite and 37% of various gangues have been submitted to my said process. It should be stated that this ore could not be enriched economically by any known means.

Only a few seconds were necessary for completely separating the sulphide of copper from the rest of the gangue in which no single trace of copper could be discovered by analysis.

EXAMPLE 2.

An ore having 10% of lead and unmarketable with such a proportion, has been treated in the same manner and with the same success. There are several operations which are distinct but which are connected in carrying the process into practice; the formation of the spherules and their separation from the gangue, then separation of the product of the concentration from the oil and recovery of this latter for readmission to the cycle of operations. The products of the concentration form cakes.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, as communicated to me by my foreign correspondent, I declare that what I claim is:—

The hereindescribed process for the concentration of metalliferous ores and earths which consists in mixing the finely powdered ore or earth with water, adding a suitable oil and then liberating a gas in the mixture substantially as described and for the purpose specified.

Dated this 4th day of March 1903.

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